BY VISCOUNT HALDANE

THE REIGN OF RELATIVITY

THE PATHWAY TO REALITY

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THE CONDUCT OF LIFE

AND OTHER ADDRESSES

UNIVERSITIES AND NATIONAL LIFE

Three Addresses to Students

HIGHER NATIONALITY

A Study in Law and Ethics An Address delivered before the American Bar Association at Montreal on September 1, 1913.

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THE PHILOSOPHY OF HUMANISM

AND OF OTHER SUBJECTS

BY VISCOUNT HALDANE

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PREFACE

If I had called this book *The Philosophy of Humanism* without more, that title would virtually have covered its scope. But the reader would not have had his attention drawn to the significance which the word 'Humanism' imports for myself.

To avoid misinterpretation I have therefore added in the title the words *and of Other Subjects.* Part I, which is concerned with Humanism in its restricted sense, contains the substance of three Donnellan lectures delivered this summer at Trinity College, Dublin.

In a volume published last year, *The Reign of Relativity,* I sought to lay the foundations of a view of the uniqueness distinctive of individuality which would show the relation of its principle to that of the general relativity of reality to knowledge. This view is carried further in the present volume, which is a companion one to that of a year ago.

As regards two of the scientific subjects discussed, I am under much indebtedness for counsel and assistance while working out the principle. Professor A. N. Whitehead, F.R.S., has gone over the proofs of the three chapters devoted to mathematical physics. My brother, Professor J. S. Haldane, F.R.S., has done the same for the chapter on biology. Neither

of them is thereby to be looked on as responsible for sharing my point of view in philosophy, or for modes of expression which are my own. But none the less my debt to them is great for having permitted me the advantage of their criticism in what I have written on their respective subjects.

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PART I

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM

CHAPTER I

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM

Humanism means what conforms to the standards of value in domains such as those of Literature, of Music, of Art, and of Religion. The standards there employed are different from those by which we test values in Science and Metaphysics There is a kind of value recognised in what we call direct apprehension which is other than that which we set on correctness in inference from general principles. Still, there must be a common standard of some kind which will bring into congruence knowledge of the most different sorts The purpose of

these three chapters is to endeavour to bring this question under the light cast by the principle of the Relativity of Knowledge. What lies at the foundation of this principle is, that when we say we know it is not sufficient merely to regard the self as a thing that establishes an external and accidental relation between something that knows and an object outside the relation of knowledge. Our personal thoughts do not make things, and yet things have no meaning, and therefore no reality, apart from knowledge. We are ourselves objects in knowledge, but knowledge not the less must come first in logical order in our interpretation of ourselves as actual. For, outside of actual or possible knowledge, existence has no significance. It was reserved for Kant to point out, as against the British School of thinkers, that when we know we are always more than we take ourselves to be, and that meaning is the essential foundation of existence. The question of the genesis of knowledge is thus an inherently irrational one. All scepticism assumes that it possesses the instrument for which it sets out to account We must, therefore, inquire what knowledge in the fuller sense imports The problem is as old as the Greeks In the relation of the Active to the Passive Reason there seemed to them to lie a solution. When we talk of thought as making things we conceive it inadequately, and represent it under the form of a set of abstract conceptions which we present to our minds as if objects The ultimately real appears to be, on the contrary, neither mere subject nor mere object, but the significance of an activity within which both are distinguished in reflection By his application of the principle of relativity in knowledge to mathematical physics Einstein has awakened a vivid interest in this subject. His application is, however, only a particular and limited one Explanation of the fashion into which he has cast it. The basic four-dimensional world and the tensor principle. A wider application to the case of the living organism. Life and mind. Levels in experience and degrees in knowledge. The form of the concrete universal is that assumed by all reality. It contains, not as separate entities but as logical moments, the universal and particular, which are actual only in what is individual and unique, and it is resolved into its logical moments by our abstractions. It is only in reflection that these are dissociated. The particular is essential for reality not less than the universal The dangers of the uncritical use of metaphors about knowledge. With this view of its true character we come in sight of the interpretation of its Humanistic phases . . . . . pp. 35–57

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THE PHILOSOPHY OF HUMANISM

INTRODUCTION

In an early passage in his *Metaphysics* Aristotle pronounces the views of his predecessors to be tainted with an artificial character. Of this he sets himself to get rid in his own view of the object world. "Surely," he says, "it is not likely either that fire or earth or any such element should be the reason why things manifest goodness and beauty both in their being and their coming to be, or that those thinkers should have supposed it was; nor again could it be right to ascribe so great a matter to spontaneity and luck. When one man declared, then, that reason was present—as in animals so throughout nature—being the cause of the world and of all its order, he seemed like a sober man in contrast with the random talk of his predecessors. . . . Those who thought thus stated that there is a principle of things which is at the same time the cause of beauty, and that sort of cause from which things acquire movement."

It is more than two thousand years since Aristotle said this. In the interval there has been enormous progress in knowledge of certain orders. Turning to facts and applying methods for exact observation and measurement the science of to-day has grown,

and is still growing. But the progress has been in the main progress in knowledge of quantitative relations. In literature and art we have not added to the store in the same fashion. We have indeed added much, but in point of quality and sense of form it is not clear that we have made any advance beyond the level reached by Ancient Greece. Glancing at philosophy, this appears to be something different from science and from literature and art. It is concerned with the significance of the universe regarded as a whole, with the same problem as that to which Aristotle devoted much of his genius.

Have we got beyond Aristotle in our philosophical outlook? If it is a question which concerns quality in knowledge the answer is not a plain one. Like Plato and Plotinus, perhaps more so than either of these, Aristotle had freed himself from certain obsessions that seem to hamper philosophical thinking with us moderns. His metaphysics and his psychology are largely critical. They consist in an effort to drag to light and eliminate unconsciously made assumptions in these subjects. It is in truth of assumptions of this type that he is complaining in the words quoted.

It is significant that Goethe, the range of whose intelligence has among moderns rivalled that of Aristotle, makes the same sort of criticism. He is not content to tell us in merely general terms that we do not know how anthropomorphic we are. He devotes many pages to the expansion of this theme, insisting that experience in every form is moulded by the intrusion of the personality of the observer, and that it is accordingly only when men work together and compare their results that anything reliable

emerges.[1] Science requires more than the work of one individual for its creation. It is the child of time sufficient to eliminate the intrusion of the subjectivity of observers, both in facts supposed to have been observed and in theories about them.

It was for this reason that Goethe took little interest in the metaphysical systems of his day, although he had given them more attention than is generally supposed. He thought them all too abstract, and he would not set out in quest of an Absolute, any more than he was tolerant towards attempts to reduce mind and matter to constructions from atomic particulars, basic to both. Like Aristotle his starting-point was the world as it seems to present itself in the fulness of everyday life. He was not troubled by the fact that this is the experience of a particular individual, for he seems to have held that the individual himself has meaning only in and through it. It is this experience, as interpreted by mankind generally through the course of time, that was his problem. He did not look for finality in such an interpretation. There was no finality for him in the forms of truth. It was, as in art, perfection in the quality of the effort that mattered. His object was not to fashion a theory of final first principles, but to eliminate unconscious prejudices. Aristotle had previously set himself to what was at least in part the same purpose.

Were these great thinkers right, each in his individual way, in what they appear to have held to a large extent in common? The question is a

[1] What he said in a number of his prose writings on this subject will be found, conveniently collected, in a volume by Max Heynacher, called *Goethe's Philosophie aus seinen Werken* (Leipsig, Meiner, 1905).

serious one. For if it is answered in the affirmative we must be critical about the point of departure in philosophy. They bade us take the world as we find it; accept its reality, as it seems, and then trace out the relativity of that reality, as it grows or 'becomes,' to our own standpoints. There is much to be said for such an elimination of metaphysical presuppositions, provided that it is thrown into the form of scientific principle. It gets rid of the controversy between idealism and realism; for the distinction between mind and matter, observer and observed, appears now to be one that falls within knowledge itself and assumes it as already there. Any particular activity in knowledge is found to proceed by way of abstraction downwards from what is most concrete, that is the actual. "Man," says Goethe, in his *Der Versuch als Vermittler von Objekt und Subjekt,* "takes interest in an object just in so far as he fashions an idea of it. It has therefore to pass into his mode of apprehension." And a little later on: "In living nature nothing happens except what stands in relation to the whole, and if phenomena appear to us as if isolated, and we have to look on our investigations into them as isolated facts, this does not really mean that they are isolated; it only raises the question how are we to ascertain the connection of these phenomena and these circumstances." Accordingly, our experience is not static, but is dynamic or self-evolving, its phases passing into each other. For clearness we *set* them in our knowledge as fixed objects for our reflection, and in so doing have always somewhat transformed them by the process of abstraction in which we do so. If this be the true character of experience, then the different

varieties of knowledge about it will differ according to the conceptions which are dominant in the abstractions so made. But all these varieties have their origin in the unique and individual entirety we name 'knowledge,' a source that is not broken up in our experience of the individual object in the fashions or degrees that the varieties of abstract reflection are; as little broken up even in human experience when it is left to itself as the limitations of the mind in which it expresses itself permit.

If the main thesis of the Greeks and of Goethe is a true one it carries with it far-reaching consequences in the adoption of method in philosophy. For it imports that what we must start with as our basic fact is first of all the world as it seems to us, the concrete many-sided world, with the whole of its riches, that appears present in our every-day experience. We must not begin by trying to find elements out of which this world of actuality is put together and pieced up. As soon as we try to start explanations of this kind we fall into the fallacy for which Aristotle criticises his predecessors, the fallacy of the abstract mind. Our experience is no passive awareness put together out of isolated elements of sensation that exist as self-subsistent entities in independence of each other. The ideas of such entities are themselves arrived at only by abstract methods, and give us merely phases within a larger entirety in which they stand in ever-changing relations which are integral for the whole. All such relations are therefore internal, that is they are inseparable from the reality of the phases into which they enter. What are termed "external" relations, and are treated as severable, are themselves abstractions, without

reality independent of the whole in which they have meaning. Meaning, indeed, enters into reality everywhere, and is of its essence.

Now the character of meaning is that of mind. Meaning imports the presence of mind and has its home there. It is beside the point to say that such mind is always the mind of a particular individual. For such an individual himself has only meaning as an object within the world as it is for mind. Knowledge as such therefore comes first. Those who try to reduce reality to isolated and self-subsistent sensations encounter the difficulty that the nerves, and the brain itself which receives stimulation from without, and so builds up the external world which has to be accounted for as inclusive of all of these, must be assumed to be present before we can conceive ourselves as having any sensations to build with. Just so the fact of individual experience has to be presupposed before we can make any departure at all. But those who thus start with experience as already there are at least free from a fatal obstacle which confronts the subjective idealist and the materialist alike. If I look at the people who are crowded into a room, listening it may be to myself who am speaking, there is a fact that confronts me. Into the sensations produced in their respective brains, by the electro-magnetic waves of light or the atmospheric waves of sound which stimulate their optic or auditory nerves, I cannot enter. These produce sensations which belong exclusively to the individual in whom they are awakened. I, the speaker, know and can know nothing directly of these sensations. They cannot come within my immediate awareness. Nor can the audience enter into my own sensations.

But yet we are certain that we see the same room and hear the same words. How is this possible? Only in one way. What we know in common cannot consist in immediacy of feeling, which is excluded from everyone excepting the person whose private feeling it is. But there may be knowledge in common of a kind that is logically quite different from mere feeling, the knowledge in common which arises from thinking about our private experiences in identically the same conceptions as others employ, and thus giving to our respective sense experiences an identical meaning. It does appear as though what those present have in common is not sensation but knowledge about sensation. Apart from interpretation such sensation amounts to nothing at all. Yet without material to set for itself into objective form the thought would be an abstraction which had no objective or individual character in which to make itself real. If it can so set itself in individual form the form becomes symbolic of the conception through which it is fashioned. Neither the lecturer nor his audience in the lecture-room seem to separate the two aspects which their individual experiences present. These vary with the individual. But in the differences there is pervading identity, and it comes from identity of form in thinking. The particularism which is the other aspect has the character of a 'happening' in space and time. But no conception used in interpretation appears to be any such happening. It belongs to a different order, one which is concerned not with events, but with what is required before events can have the meanings that have to be inherent in them if they are to belong to reality.

It was something of this kind that Aristotle appears

to have meant when he distinguished the Passive Reason, which operates in human form in the world of which we are denizens, from the Active Reason which that form and the world itself presuppose as foundational to them. I am speaking of his Metaphysics, rather than of his Logic. These two forms of reason were not for him separate entities. The ideal completion or truth of the Passive or human Reason was just itself 'become' the Active Reason. Such becoming could never be adequately accomplished in time or under the conditions of the human organism, but it was due to the activity of the supreme form as the end which was determinative, an activity not merely in time but in thinking. Such activity was no happening of events, but was presupposed in the significance of all such happening.

Modern versions of what is called objective idealism embody principles which are analogous. But just as sensationalism veers over into the idea of thought as a construction by or an activity of things, so there has been a tendency in modern times to speak of things as though constructed by thought. The strength of the Greeks was that they were not prone to these temptations. The reason was that they did not dream of subject and object as different *things*, or as being more than correlated phases in a single basic activity. Where, as is often the case, they hesitate about the singleness of the process, it is not because they are seeking to distinguish these as things or objects in a world of experience. With all their shortcomings in precision of language they had not to bear the burden of our modern obsessions, arising from the hypostatising methods which were almost inevitably consequent on the contracted view of the

inwardness of facts observed which followed on Bacon's work for science.

Those assembled in a lecture-room have thus identities before minds which differ numerically only in that the organisms in which they express themselves differ numerically as objects in space and time. But these objects are individual, that is to say they are actual objects only in so far as judgment through universals as much as the particularism of feeling enters into their character. As I shall endeavour to point out in the subsequent chapters of this book, that is how these objects are real as well as significant. The particular of sense could have no meaning at all for us, and therefore no existence, but for its setting in universals imported by some mode of reflection, however slight. In this fashion concepts enter into the constitution of reality. Because of the distinctions with which the particularism of the actual is so endowed, mere logical identity becomes identity in difference, or correspondence. It is correspondence in our conceptions thus based, not on 'happenings' which are necessarily diverse, but on identity of thought, that makes us experience the same lecture-room, the same sun, moon and stars, and, generally, the same world. A single world is before us by reason of an identity in our thinking apart from which it would not be there in common for us.

It is for such thinking and only for such thinking that space and time themselves are present and are possible. Such reflection appears to be foundational for the very possibility of an object world, and of ourselves as in that world. We are therefore more than we take ourselves to be when we regard ourselves as our own object and hypostatise knowledge into a

property of this object. Something of the kind Kant told us, but not altogether consistently. In another, but I think rather partial aspect, Bergson also has expressed it. And it is interesting to observe the traces of this foundational view of the activity of reflection in what was written, nearly half a century ago, by one of the most acute of modern British thinkers, W. K. Clifford. In his Lectures on the Philosophy of the Pure Sciences, delivered at the Royal Institution in 1873, he says that in all our sense experience there is a part which comes from the external world, and a part supplied by the mind. Not the whole of a sensation is immediate experience, but "this experience is supplemented by something else which is not in it." Motion, for instance, he says, we imagine according to the rule of mathematical continuity. Between the distinct pictures which we have on the retina we insert an infinite number of intermediate pictures. The motion is imagined according to the laws of geometry, that is to say, it is so imagined that the relations of distance at any instant obey these laws. The rules according to which we analyse and ascertain its nature are the laws of the pure science of motion, kinematics. Putting the matter more generally, "we supplement our experience in accordance with certain rules, and some of these rules are the foundations of the pure sciences of space and motion." In an approach to an anticipation of what Minkowski was to say more than thirty years later, he goes on to declare that he speaks of space and *motion*, because he thinks it more correct to hold that "we imagine time by putting together space and motion than that we imagine motion by putting together space and time." He then

proceeds to discuss what is called the continuity of things. "Things—that is to say, combinations of possible experience—are not persistent, but they change continuously in the imagination by which we fill up that experience." Number is just as much a conception of reflection as is the relation of continuity with which geometry is primarily concerned. We group things by using language or by signs, such as we get by counting on our fingers. We thus form 'complicated conceptions,' imaginations of series of things and their combinations. "We carry about with us a certain apparatus of counting, which was primarily our fingers, but is now extended into a series of signs which we can remember in a certain order—the names of numbers. Our language is so formed as to make us able to talk to ourselves about the results of counting. The propositions of arithmetic are compounded in general of two parts: a statement about the counting apparatus, and a statement about the different ways of describing its results." There is an assumption which underlies the foundation of the whole science of number. It is, he says, that when we count, for instance with our fingers, while the order in which we use our fingers is no doubt fixed, we make the assumption that a group of things comes ultimately to the same finger in whatever order they are counted. Of the things taken in the original order the last one touched is, say, that one which my thumb touches. It is assumed—in oblivion that it is a principle that is just assumed by the mind, that if the things are taken in any other order and applied to my fingers the last one touched will be the thumb. This proposition is, he finds, the foundation of the whole science of

number, and he gives credit for its elucidation to Cayley and Sylvester. His theory of mental apparatus of different kinds he applies to the character of space. He points out that the space of Euclid is conditioned by certain assumptions which we have introduced into our knowledge of it, with the result that it is taken to have no curvature, whereas it may equally well, so far as closer analysis of the fact may show, have a negative curvature, like the space of Lobatschefsky, or a constant positive curvature. In this last view it is clear that he finds himself in the main in accord with the reasoning of Riemann. In the volume of mathematical papers which was published after Clifford's death, there is a rendering into English of Riemann's famous essay on the *Hypotheses which lie at the Foundations of Geometry*. In that essay Riemann, as Clifford was to do a little later in a different fashion, had set himself to the task of constructing the notion of a multiply extended magnitude out of general notions of magnitude. It followed for him that a multiply extended magnitude was capable of different measure relations, and consequently that the space which we take to be actual was only a particular case of a triply extended magnitude. He therefore concluded that the propositions of current geometry could not be derived from general notions of magnitude, but that the properties which distinguish actual space from other conceivable triply extended magnitudes were only to be deduced from experience.

Put shortly the outcome for both of these mathematicians was that, in the object world with which mathematics deals, conceptual thought enters into and is inseparable from the constitution of reality,

which is in this sense relative to our knowledge of it. Clifford did not think that Kant was right in holding that in knowledge there are genuinely pure *a priori* forms which are imposed on the substance of the object world as it were *ab extra*, and apparently he did not realise the methods in which this semblance of a breaking up of the entirety of knowledge on the part of Kant had been sought to be got rid of by later metaphysicians. Believing, however, with Kant that there were forms in knowledge contributed by mind, he appears to have held that there were simple ultimate elements of 'mind stuff' which constituted the structure out of which thought and feeling were both built up. That principles which dominate and shape thought should have become implanted in knowledge, as the outcome of activity on this basis, he attributed to evolution aided by heredity; so far in agreement with Herbert Spencer. Subject to this, and as evolved in this fashion, he seems to have considered mind so conceived as the ultimate reality.

The result of this fundamental conception was potent in his mathematical investigations, and led him to anticipate much that has since emerged in the mathematical physics of Relativity. Riemann's teaching he grasped and appreciated as almost no other did. Those who have read the fragments on philosophy at the end of the volume containing Riemann's collected works, will appreciate the bond between the two men. Well may Professor Weyl pay the tribute to Clifford's genius which is quoted later on, at p. 181.

The thinking in which the world of objects has its foundation is no event to be looked on as a particular

object among others in the world to which it gives the significance of reality. Nor can it be an attribute or activity of the self as an object in that world. Such a self is made present to itself as object only in an abstraction which does not yield the whole truth. The entirety appears to be that activity of knowledge within which not only object but subject, for which it is object arise. The genuine subject aspect within this entirety remains intact in the abstractive process which segregates the object but cannot reach that for which it is there. It is only by watching thought develop itself in its own self-implications that we can discover its nature. The process must be in its essence one of mediate inference. For in what we call self-consciousness we are always tending to make the abstraction which identifies the self with the thinghood in which it expresses itself even for the mind that is aware of itself as knowledge. From that knowledge, from what experience implies and reveals, we start. We assume it as our point of departure and behind it we cannot get by any direct inspection. But although we cannot by analysis resolve our experience into further elements out of which it is constructed we can by analysis study its nature conceptually, as we do in logic. Only the logic must be one in which the facts are simply made free, through the exclusion of what is foreign to them, to do justice to themselves by revealing their own implications. Something of this kind we seem to approach whenever we are brought to the sense of the fullest reality, in poetry, in art, in religion. The sense which comes to us in instances of this kind is not developed knowledge, for such knowledge is fully intelligible only when it assumes rational form

in conceptions that are not fragmentary but belong to an entirety. Such conceptions it may be impossible for our minds, conditioned as they are by the physical organism in practical possibilities of retention and expression, to fashion forth in the completeness of their system and relations. It is always, as I shall point out in the chapter which follows in this book, in individual form, that is, with the moment of the particular implied as present, that we know, even when we appear to reason abstractly. But at least the insight thus gained into the nature of knowledge delivers us from the mistake of supposing that we have exhausted the entirety when we have analysed, be it never so apparently fully, the object aspect which it always presents. For this thesis, and as plainly supporting it, it would be easy to cite witnesses, not only from the domains of poetry, art, religion and philosophy, but from teachers such as Riemann and Clifford and their successors of to-day, as well as from inquirers in fields other than those of mathematical physics.

The doctrine that the origin of knowledge may be found in habitual association in contiguity has to encounter this initial difficulty. How is a series or aggregate of contiguous impressions possible except as presupposing the knowledge within which it is presented? Assume such knowledge as conceded, then the association principle becomes very useful as showing uniformities in the ways in which ideas treated as external phenomena suggest each other. But it is of no value in throwing light on the genesis of a knowledge which it has already presupposed for its own foundation. Sensations, even if we could conceive bare sensations, would not bring other sen-

sations into being by suggestion. For it is only ideas that are suggested.

We are thus forced back to the *subject*, which is itself no event happening in externality, for the explanation of the world as it actually seems to us. By subject we mean here neither a thing in space nor an activity in space. We mean that for which such things and activities are, and apart from which they have no significance and so no reality. Thus interpreted the presence of the subject aspect of reality, of knowledge as that to which reality is essentially relative, is everywhere apparent, even in what, looked at superficially, we take to be a mere object world. I meet my neighbour in the street. Abstracting from other aspects which he expresses for me I can regard him as consisting in only so many pounds' weight of chemical stuffs, atoms and molecules. But this aspect rarely interests me. I come nearer to my habitual point of view when I look on him in another aspect of his factual relativity to knowledge, the fact that he is a living organism. For this concerns his health. I may hold a policy of insurance on his life, or I may be dependent on him, and therefore desire his continuance in existence as any parasite might do. But none of such aspects are adequate to his *personality* for me. What he expresses above and beyond all these is meaning for me of another kind and level. He is a thinking being, he reflects, he has a store of knowledge and of memories, he is a fellow citizen, he is my friend for whom I have a deep regard, he and I are equals and identical in this, that we both say 'I' and are the centres of our own conceptual worlds. Physically he occupies a different part of space from myself. Spiritually he does not,

for our concepts and our modes of thinking are based on what are logical identities, and are not occurrences in space and time at all. As a physical object he is indeed numerically different from myself, but if that were all I could not know him as a self standing in relation to me, another self. Identity has in certain aspects superseded difference. In virtue of such identity I attach significance to external activities on his part, such as speech, which are for me symbolic. Meaning enters into the very essence of reality in this connection. That is the foundation for me of my recognition of personality in him. He says 'I.' This gives to the activities which his freedom in volition and self-control fashions a significance which is, throughout divergence in external form, identical with my own. For I, too, say 'I' and act with self-determination accordingly. I am subject and he is subject. We do not explain this subject nature as a physical object built up out of external happenings. For, apart from the common world which we have in virtue of being subjects who know identically, external happenings could have no meaning for us. It is of course true that each of us has been developed from the union of a spermatozoon with an ovum, and that our organisms are the result of a long process of evolution and inheritance. This concerns the aspect which is that of life, just as oxidation concerns the aspect which is that of chemistry, and gravitation that which concerns the material through the metabolism of which the organism functions. But the processes of evolution and inheritance belong to the object world, which, with time and space, are there only for knowledge. Even if we think of a cosmos before any living or intelligent being appeared in it

that remains true. Such a cosmos of course would present itself as an object, or idea of an object, within the world as it is for knowledge, and would have no significance excepting as a construction in knowledge. It is a conception got at by an abstraction which is quite legitimate for limited scientific purposes, but has no application in an inquiry into the ultimate nature of reality and of its relativity to knowledge, taken as more than itself an object within its experience of the object world. If my neighbour and I were not more than mere objects for knowledge, and did not express in some aspect the foundation of knowledge itself, we should not only contemplate no such cosmos, nor any past, present or future, but we should be impenetrable to each other. In short, we should not exist.

We see thus the potent effect of abstractions in fashioning for us our universe. With abstractions we have in the main to be content to dwell. For, as Goethe said, he who would accomplish anything must limit himself, and it is only by limiting our activities and directions in knowledge that we can exercise the degree of concentration that is required to render it distinct and progressive. All scientific method proceeds by way of concentration on methods which are of necessity partial. The part played by philosophy, which has to observe mind as it applies its activity in its freedom for self-development, is to be the observer and recorder of the process in its varying forms. Philosophy dare at no time forget that knowledge belongs to an entirety in the sense of the expression already discussed. It dare no more forget that mind is never static but is continuously active in the changing dispositions it makes. Knowledge is con-

stantly passing beyond the distinctions which it sets up and including them in larger wholes. That is why the Greeks called the activity of knowledge 'dialectic,' and why some such term is still required. In looking at mind from the level at which it presents itself as subject in knowledge we ought not to try to distinguish it from knowledge itself. There is no real distinction in meaning between the two names, and to speak of mind with special emphasis on that word suggests, just what we ought to desire to avoid, the idea of mind as a thing.

These considerations raise the question why the starting-point from which we set out in the inquiry into the character of reality is spoken of as either knowledge or as mind. Now this question appears to be a very legitimate one. As I have already said the word 'mind' is apt to suggest thinghood. On the other hand knowledge conveys the impression that what is merely abstract is intended. Such suggestions would be, it is needless to add, quite out of place. What we have to do, if the purpose in hand is to be carried out, is to try to express the actual as starting-point, just as we find it, and without sheering it, by any process whatever of bifurcation, of aspects in its reality. Now the actual is nothing that stands still. Distinctions are always developing themselves within it. Even its limits are always altering both in extent and in content. We may say that the actual is experience, if we are careful not to import into our meaning any delimitation of object from subject as separable from it. In other words, experience in this sense means the entirety within which both fall. Past, present and future fall within it likewise. Those who have read Minkowski may notice

that the analytical conceptions he employs in his presentation of his idea of the real world for mathematical physics appear to be far from out of harmony with the last sentence. Widened in this fashion, and taken as covering all its own implications, experience becomes indistinguishable from knowledge, if knowledge is given its full meaning. For knowledge as it is expressed in us includes not only what we treat as abstract conceptions, but the feelings which they qualify and set in various orders. We distinguish them. But, as all knowledge of objects is of objects in individual form, general and particular are not separate factors here, but are just logically distinguished moments, real only in their union in the form of individuality itself and separable only by abstraction. To this topic I shall return in the ensuing chapter. Knowledge completely interpreted appears to be neither general nor particular. If it is always expressed in its objects in a form that is individual and so unambiguous, it would appear natural that in other aspects, those in which it signifies self-awareness as subject, we should not look for any different aspect. Human knowledge is rendered incomplete in its self-expression by the organic appearance to which it gives significance as intelligent. Were it to express itself at a level less partial, in which it could attain completion, it would be God's knowledge, within which the entirety of the universe, the subject as well as the object, fell without distinction, and in which all abstractions and degrees distinguished from each other presented themselves as belonging to an entirety every phase of which was comprehended in its proper relation to the whole. Into speculations on such a possibility we need not

enter. It is enough for us that the distinctions which fall within our human knowledge, although they seem to be imposed on it, are brought about by itself and not *ab extra.* The influence which brings them about is apparently immanent. There is no reason for assuming any external boundary between God and man. None the less for man his knowledge is never creative, in the sense in which to think and to call into existence are one and the same act. The difference set up between these is however one to be sought within and not without ourselves. It is also not the less on that account real for our practice as human beings.

Such an interpretation of human knowledge leaves us free to make it a point of departure which is, for us at all events, foundational. It is no new interpretation. To imagine that it could be so after many centuries of the striving of thought to reach the basis of reality would be contrary to common probability. It would also be to misread the records. The history of philosophy discloses the constant recurrence of such an interpretation in varying forms. We find it alike in the philosophy of India, and in that of Ancient Greece. We find it in Neoplatonism. We find it striven after by the Schoolmen. We find it again in the renascence of speculative activity in Europe, and we see it, both latent and in overt expression, in Kant and the so-called Idealists who have followed after him. But in the interpretation we may give it to-day it is hardly Idealism. It is rather a transformation of Realism. The necessity for it has been brought about by recognition of too contracted views on the part of those who thought that physical and natural science could be made com-

plete without reference to philosophy itself. Science gives us truth which is invariably relative. Philosophy does not seem to give us final truth. It dare not, if it understands its own business, warrant its result as ever being either final or complete. What it can do is to drag relativity to light, and perform the essential function of the critic of knowledge in its various aspects. Its work can never be ended, for it is always being called on to deal with the new material which science is producing. It has not, as is usually the case in science, any possibility of resorting to external standards by which to measure its results. But it can assign the values, possessed in different orders in knowledge, of such measurement. To desire itself to measure in such a fashion would be to misinterpret its own function. It is akin to literature at least as much as to science in this, that it is concerned as is literature with quality, and is not merely concerned with relations of quantity.

No more, then, than in the case of poetry can philosophy hope for finality. But it may hope for progress in the quality of its interpretation, and in the width of its grasp of the facts presented by the sciences only in special relations. The task, in short, of philosophy is that which Goethe assigned, when he insisted, as was remarked early in this Introduction, on its being essential that men should work at a common task, and compare results attained only after the lapse of a long period of work in common, if anything reliable was to emerge. It is in the quality of the struggle to attain it, and not in any finality we suppose ourselves to have reached and to be entitled to rest on, that truth consists for human beings. It

is only by striving daily to conquer them anew that we gain and keep our life and freedom.

But if the historical development of philosophy has not brought us to anything that we are entitled to regard as final truth, it has at least shown us how narrow much of our thinking has been, and how we are prone to lapse into abstractions. Call it mind, call it knowledge, call it experience, the criticism of method in the search after the ultimate foundation of reality has at least brought to us certain lights. It has eliminated merely conventional problems. However we name the basis from which we start, this seems clear; we cannot dissociate it into constituent elements, and what we call nature is itself an abstraction from its more concrete reality. It is only if we have these things always before our minds that we can hope to analyse the character of a basis which is itself foundational for all analysis.

There are, in particular, two present-day schools of philosophical thought which take up different attitudes to this conclusion. One is that of the modern Italian Idealists; the other that of New Realism. The first of these claims to be able to carry the conclusion just indicated to still more definite developments. In his book on the *Theory of Mind as Pure Act,* which we here are under a debt of gratitude to Professor Wildon Carr for having translated into an admirable English version, Professor Giovanni Gentile, of the University of Rome, has set forth an idealism which is akin to, while yet differing from, that of Croce. In the third chapter of his book Gentile describes the character of mind in terms which exclude all notions of it as substance, and display it as pure spiritual activity. His idealism

is the negation of any reality which can be opposed to thought as independent of it or as presupposed by it. The subject is a purely constructive process in which the object is evolved, and is therefore never itself object nor being nor a state of being. All that *is* turns out to be the constructive process itself. This is pure activity within which all forms arise, including that of the self when sought to be made object, a form which is thus only derivative and is not a true one. The phenomena which mind produces in its continuous self-development may assume an apparently static form. They do so because of the limitations of the end to realise which mind has made them what they are. A stone *is* because it is already all it can be, and has realised its essence. The restricted nature of objects is a consequence which follows from the fact that everything is presented in its relation to mind as a reality which presupposes knowledge. But mind itself is not so presented. It is the source of its own laws, and is not restricted to a definite nature in which its process is exhausted and completed. It is no object but is opposed to objects. It is process or act and is limitless. "Just as all which has been understood is nothing in regard to what we want to and are yet unable to understand, so likewise in the moral life all the merits of the noblest deeds hitherto performed do not diminish by a hair's breadth the sum of duties there are to fulfil and in the fulfilment of which the whole value of our conduct will lie, so long as we continue to have worth as spiritual beings." *Verum est factum quatenus fit.*

The value of this form of Idealism pushed to the extremes which characterise it lies in its insistence

on rejecting the category of substance in its application to mind. The method rejects the psychological view wholly in favour of a different method, wherever the purpose is to get at the final nature of the real. In so doing it can hardly render justice to science, or appreciate adequately the respective values of the degrees or varying levels which knowledge discloses. There appears to be little room for any principle of degrees in an idealism which is so determinedly opposed to the claim of the object world to present intelligence as a fact disclosing itself in different levels at which it rises towards mind. There is but little room left for the world in any such system of truth. The strength of Gentile's reasoning lies in its affirmance of unity, and it remains to be seen whether its apparent degradation of multiplicity in aspect leaves philosophy free to fulfil its mission of doing justice to all forms of knowledge as they present themselves. If it fails in this it may have to pay a penalty by being in the end adjudged inadequate as descriptive of reality.

Not the less Gentile's analysis is a penetrating one. In the chapter on Space and Time in the book referred to he makes some observations which are especially valuable for those who hold both to be unintelligible apart from construction in reflection. For Gentile space and time are the two general systems of the manifold in nature. To affirm such a manifold is to affirm space and time. To imply the reciprocal exclusion of all the terms of the experience of manifold objects, we resolve into elements and finally into points, each of which is outside the other, and has all the others outside itself. The points are ideal

constructions; we do not find or distinguish them in experience, yet we cannot but treat them as inherently distinguishable in the order of experience as conceived in reflection. Each point in space is a centre for all other points, and thus taken by itself would render multiplicity impossible. For the point is a limit of space, and is therefore itself not spatial. But the point which is 'here' does not remain in uniqueness, or as a centre which excludes from itself multiplicity. It is a 'now' which, without spatial change, becomes a 'then' implying by its very character other points which are now or will become so. In this fashion time is the spatialisation of the centre from which arises the unity of the multiple nature of space. It is on this account that space and time can be schematically represented as two intersecting lines having only one point in common. A unique point in space cannot be such unless it is also one among many points in time. The conception of space thus completes itself in time by becoming an absolute multiplicity, every element of which is itself a multiplicity. The conception of time is different. There we have to arrest the spatial process by fixing a point in space in order to understand the instant which is generated by the multiplication of the spatial point. There is a new spatialisation of the first element of space. If we conceive space as a pure multiplicity immediately given we cannot withdraw from it any of its units without having to conceive this unit in a second pure multiplicity. The reality in the case of space is spatialisation. Co-existence is the convergence of all the points of space to a point of time to which all other points are related as outside it, so that it is the negation of their multiplicity. Com-

presence is the convergence of all the moments of time (past, present and future, in their distinctions and multiplications) in a present now, which is not in itself something between a past and a future, but is a negation of all such temporal multiplicity and of all succession. It is not duration, for this implies space, but is a negation of what distinguishes time from eternity. Space is the spatiality of such a point, and the point is in itself non-spatial. Time is the temporality of the instant and the instant is in itself non-temporal. That is only possible in so far as they are forms of the activity of thought. Nature is only intelligible as the life of mind. To use W. K. Clifford's phrase we 'fill in' our experience.

New Realism stands as the very antithesis to this. It seeks to go behind what is called knowledge, and to find all that is within nature, which it resolves into a complex of self-subsistent entities with relations that are independent of them as they are of the relations. In this sense the relations are called external. The whole of both the entities and the relations can be completely described without reference to mind. The latter may or may not have an existence of its own, but it is an existence which is not required for the explanation of our object world.

New Realism tends to the resolution of reality into series and groups of atomic sense data, standing in relations to each other which are not only as real as the atomic data they relate, but are of the character of universals. By this recognition of the reality of universals it is distinguished radically from materialism and from the old-fashioned sensationalism. It will be observed that in this view there is transferred to the object world a great deal that for other

schools has been equally recognised as essential in the constitution of the object world, but as being there inasmuch, but only inasmuch, as that world is what it is as the object of knowledge. One of the difficulties with which New Realism appears to be confronted is that it seems to stop, in its acceptance of general relations as inherent in the self-subsistent object world, at relations of certain kinds, such as those of mechanism. Some of its most prominent adherents do not even hesitate to suggest that the basic relations in the universe may all be expressed in the form of differential equations. But this suggestion brings the theory to a test. If the relations with which mathematical physics is exclusively concerned are thus to be bifurcated off, what of the infinity of other relations which confront us, for example, in the case of life. These must be either reduced to a mechanistic form or else ignored as not belonging to what is actual. The same difficulty arises when we turn to the domain of ethical phenomena, and have to take account of personality, of duty, of freedom, as phenomena apparently confronting us. So with the phenomena in the domains of art and religion and of other regions which we think of only as mental or spiritual. These appear, not less than what the standpoint of mechanism discloses, to belong to objectivity. Are they to be transferred to the objective side likewise? There is no reason why they should not be. But such a conclusion would entail consequences. One of them is that the difference of the object world from mind disappears and subject and object seem alike to become phases within a larger entirety for which New Realism has no place.

On the whole the Italians and the New Realists may be left to fight out this battle of extremes. In the end the controversy may tend to adjust itself.

I have now said enough to indicate the principle which I have endeavoured to apply in the chapters which follow. It remains to state in what the substance of these chapters consists.

My purpose is to bring to light the characters of the standpoints assumed in various sciences to be adequate for the explanation of the aspects of reality with which they deal. What the standpoints are depends on the conceptions which define and limit them. In so far as reality is relative to knowledge reality therefore presents itself as belonging to various orders which have to be distinguished. Into an individual phenomenon the categories of more than one of these orders may enter. In *The Reign of Relativity* I was concerned mainly with the fashion in which knowledge enters into and fashions reality. Want of space prevented me from doing more than deal with the question as one of principle and from following the principle into its application in detail in science. In this volume I have sought to add what is concerned with the application in detail. Not the whole of it, for I have restricted myself to mathematical physics, biology, and psychology. But even in these domains alone the ground to be covered is so extensive that I am well aware that it is only a few of the main features that I have been able to deal with. These features, however, are indicative of certain root conceptions, and these I have tried to bring to light. The whole task for its completion would require the investigation of other fields, such as those of ethics, the theory of the state, jurisprudence, art and

religion. How a proper inquiry has to be fashioned for these I have indicated, but only indicated, in the chapters of the earlier book in which their treatment is approached. I have not tried in the present volume to revert to these subjects again. The task would be an enormous one. Indeed, the task of the present and limited inquiry is a great one; and requires in reality a much closer training in the special subjects than I have the privilege of possessing. No one knows this better than I do. But then I am not setting myself to attempt a series of expositions of special sciences. What I am concerned to do is to endeavour to bring out the relations of certain sciences to each other and to knowledge, relations which depend on the principle of relativity in its most general form. Now this is work which lies beyond the limits of any single science. It is a task which is that of philosophy, and in these days philosophy fails if it shirks the effort to grapple with it. More and more philosophy is becoming dependent on materials which the sciences alone can provide for its work, and more and more it is becoming plain that immersion in particular sciences is apt to bring with it a tendency to some form of dogmatism, based on the assumption, usually made quite unconsciously, that the method and conceptions employed are adequate for the description of reality in its entirety, and not merely in special aspects.

Holding this to be the case I have sought, before entering on the treatment of special standpoints in science, to examine in the first place the form of all our knowledge as such. This appears to me to be that the object of knowledge is in all cases individual and unique, that is to say, includes a particular as

well as a universal character. These characters, or moments as I have called them, are not, however, as is too often assumed, separate entities in the whole, which is the point of departure. They are neither separate nor separable, otherwise than by abstractions made reflectively. I think that the neglect of this distinction has given rise to much confusion in philosophical thought. Of course the kind of reflection when brought to bear varies and, as it varies, different kinds of emphasis are laid on the aspects of particularity or universality, as the case may be. It is this difference in emphasis, carrying with it difference in standpoint, that lies at the foundation of the difference between Humanism and Science. To the treatment of this foundation the first three of the chapters which follow are devoted. They were delivered in the summer of this year as the Donnellan Lectures at the University of Dublin, and they serve with the present Introduction as a preliminary study for the remainder of the book. They are printed almost as they were delivered. I fear that those who may have hoped to find them full of matter that is humanistic in the usual sense of the word, and a relief from discussion of dry topics, will be somewhat disappointed.

The chapters which immediately follow these are directed to the implications of the standpoint of mathematical physics. I am fully conscious that mathematicians and physicists will say with truth that they are on the face of them not written by one of themselves. That is abundantly true. But it is not the details of mathematical physics on which I am venturing to pronounce opinions. It is on certain questions which the mathematical physicists are now

being called on to face in a fashion in which they have not been summoned before. Physics and metaphysics have got into a territory which is a monopoly of neither, and the students in these branches of knowledge have to try to assist each other to a full consciousness of the nature of the knowledge employed and of its methods. If to say this be to make something in the nature of an apology I make it freely.

As to the later subjects, the chapters dealing with them speak for themselves. In the concluding chapter of the book I have sought to bring together results I seem to myself to have reached.

PART I

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM

CHAPTER I

SCIENCE AND HUMANISM

I HAVE chosen, for the subject of these three chapters, the "Philosophical Significance of Humanism." Under "Humanism" I include what conforms to the standards of value in domains such as those of Literature, of Music, of Art, and of Religion. The standards we employ in these domains stand in some contrast with other standards by which we test values in science and in metaphysics. They imply on their faces reference to self-conscious personality, and they are less abstract.

None the less my purpose is to find if possible some common denominator for all knowledge, and to bring within the light cast by the principle of its relativity the aspects of human experience which stand in contrast with what we call scientific knowledge. In touching on the general relativity of all reality to knowledge, I will first of all seek briefly to make plain what I mean by knowledge, and the interpretation I place on its relation to reality. This renders inevitable a reference to philosophy. To philosophy I will therefore direct myself in the first place; I hope although concisely yet not dogmatically or obscurely. Since, however, I devoted a good deal of space to this particular question in a volume published last year, I do not propose now

to do more than is essential for bringing out the significance of a general principle.

What the principle of the relativity of knowledge really imports is that when we say that we know, it is not enough to think of the self as a sort of *thing* that establishes a merely external and accidental relation between what knows and the object known, as if that object had its existence independently and outside of the relation in which it is known. What we know even most directly seems, when we look more closely than we do in common life, to have neither meaning nor reality apart from being an object for the subject in knowledge. I do not mean that our individual thoughts make things. For it is plain that we individually are ourselves objects within the general system of experience, just as much as are the other things we know. But I do mean that in logical order the fact of knowledge must come in the first place, and that the nature of what is known is not actually different from that of the knowledge for which it is there. Existence is nothing for us apart from its meaning, and meaning belongs to existence only as known. Outside meaning for knowledge, actual or possible, being has no significance and no reality. What I can in no sense conceive cannot intelligibly be held to exist. Bishop Berkeley saw this so far fully, as his predecessor, John Locke, had seen it partially. But Bishop Berkeley, nevertheless, went on to divorce existence from meaning along another line. Our ideas he declared to be self-contained and independently subsisting phenomena of our minds, and the orderly relations which made them belong to a system, and so be significant, he held to be something added to what he took to be a self-contained exis-

tence of these ideas, by the work of a God operating on the mind *ab extra*. Then came David Hume, who asked what we knew or could know of this orderly arrangement *ab extra*. No more than Locke knew of the substance, with its primary qualities, in which the latter sought the explanation of reality. But Hume proved to have himself assumed the presence of systematic and reliable knowledge as the foundation of the possibility even of his own scepticism. He could not explain how the self, if resolved into a mere succession of impressions and ideas, could know or be aware of itself as intelligence or as what experience shows. It was reserved for Kant to point out that when we have experience we are always more than we take ourselves in direct experience to be; that knowledge is the essential condition for any experience at all; and that the meaning which is intelligible only in so far as that experience is there for knowledge, is essential as the foundation of the existence of any object world, even of ideas.

If this be true, then in the universe the knowledge for which that universe is there must be recognised as the primary fact. Behind this fact we cannot get. For every question directed to the genesis of our knowledge, as of an instrument or dependent relationship, assumes it as already there present in some form from the beginning. We ourselves, conceived and apprehended as objects which know, fall within the field of objects in knowledge. The question of the genesis of knowledge in general is accordingly an irrational one, and the presence of knowledge in possible if not yet actual perfection is assumed in every form of the scepticism which is thus compelled to start by presupposing knowledge as its own reliable instrument.

This is a doctrine as old as the Greeks. Not only did they grasp it fully, but by Aristotle, and by Plotinus after him, it was seen clearly that knowledge can have before it only what is akin to itself. For them full knowledge was the νόησις νοήσεως, the Active Reason, the unity of thinking with the thought which thinks itself and knows itself alone. Passive Reason was one among the subordinate and derivative forms in which knowledge presents itself to itself. We find the same principle less perfectly enunciated by Kant, and more definitely by some of the objective Idealists who came after him. Thought does not make things, because when we talk of thought *making* them we have conceived inadequately, and have ignored the basic character of thought, taking it too narrowly as an activity of abstract construction which we present in object form before our individual minds. The ultimate reality is neither subject nor object, but is the fact of the significance which embraces both, and in which they are, as it were, poles which we distinguish only in reflection.

This principle had of late ceased, in these days of scientific inquiry tested only by measurement, to interest the public, until quite suddenly, in the present century, it received a new application in the domain of science itself. In the hands of Einstein the principle of the relativity of knowledge has been applied in a fresh form. Confining himself to the domain of mathematical physics, he has developed a standpoint that appears to be revolutionary, more startling in its scope than even that of Copernicus or of Newton. For he has denied the independent reality of both space and time, and has pronounced them to consist merely in certain relations belong-

ing to knowledge between the observer and what he observes, which vary in shape and measurement with the situation and conditions of the observer himself, depending as they do for their significance and for their reality also on whether the observer is taken to be at rest or in motion.

Newton held the view that we look out on a world which exists quite independently of our knowledge of it, and that space and time are analogous to forms or frames subsisting in themselves and independently even of the objects in them. For him space and time were under all circumstances uniform everywhere. A foot and a second had the same significance throughout the whole universe notwithstanding differences in the conditions of observation. They never changed their significance. Those who followed him therefore inferred that if there were, as was held until recently, a physical substance called the æther which filled space and time, but in which objects moved freely and without friction or retardation, this independent substance could be used as a medium in which light might be taken to be in motion relative to it, and accordingly as a standard by reference to which its velocity could be estimated as being an absolute velocity. It was, however, discovered thirty or forty years ago that the velocity of light disclosed itself as appearing to be always the same, whether we were moving through the æther towards its source, or whether, when we sought to measure that velocity, we were stationary. How was this apparent constancy to be accounted for? It seemed impossible to explain if space and time and the æther were independent and unchanging existences, unless indeed the æther perchance contracted our

measuring apparatus in proportion to the rate at which we advanced through it. For this hypothesis there was no particle of evidence, and it could only legitimately be resorted to if the apparent uniformity for observers under all conditions of the velocity of light at 186,000 miles a second could not be explained more simply. It was the simpler alternative explanation which Einstein's principle yielded that has constituted one among a good many other reasons for accepting it as inevitable. By the new principle, as I have said, the independent reality of space and time was denied, and they were defined to be varying relations, established as such through interpretation on the part of observers varying in situation. What we actually observe is, for Einstein, not space and time, but at most the basis on which they are erected as constructions of reflection. This basis is what he calls the four-dimensional manifold, or the continuum. It is, in point of scientific knowledge, antecedent to space and time, but has some qualities analogous to their qualities. Still, in this manifold the space-like and the time-like characteristics do not exist in independence. They imply each other in the entirety in which alone they are actual. Such an entirety has as its nature to be activity, a passage of mere events, a multiplicity of world-lines of change. What we are primarily aware of is thus only change in events not yet differentiated into objects with shapes and measurements. But it is the foundation of physical reality, and it is upon and out of it that there are developed in our minds space and time, and the objects whose relations and whose relations to the observer constitute the meaning

and the reality alike of space and time. They thus become actual but only relatively so.

Mathematical analysis of a highly refined order has furnished principles by which the character of the activity within the manifold, taken by itself, may be defined and described. It cannot be measured, because we have not yet reached the stage where measurement first gets a meaning and is possible. But there are general principles of a nature that is at least as much qualitative as it is quantitative, which ascertain characters in the manifold dependent on bare coincidences in the world-lines of the activity of which we are aware as basic, and these are independent of all the particular measurements which can only be superinduced after definite spatial and temporal relations have been differentiated in knowledge and set up. Such general characters yield definitions of a new kind for the general nature of change in position of events, such as that expressed in what we call gravitation and energy and matter. They hold good whatever the nature of the superinduced space-time system arising for an observer in a particular situation of motion or rest may be, such as his altering situation in a gravitational field. Obviously his space-time systems will, on Einstein's principle, vary, but here we have what is true in all space-time systems because it expresses relations which obtain in the foundation of every possible relation of the observer to the object, however it may vary with the conditions of observation. It was by reference to this kind of foundational standard that Einstein was able to predict that when the British Astronomical Expedition was, on the 29th of May, 1919, about to observe the

deflection by the sun of the rays from fixed stars coming to us during its eclipse, it would find these rays to be deflected by an exact amount in addition to that predicted by those who calculated on merely Euclidean and Newtonian principles. He said that the situation and motion of the observer on the earth, relative to that in the system of the sun, would give rise to a space-time system different from the uniform system which Newtonians assumed, in which it would be found that the lines of light would be curved and not straight, simply because the space in which they were visible must itself be curved and not straight. The name given to the principle embodied in the mathematical expressions for the foundational characteristics of every form of space and time is the Tensor principle. The employment of tensors enables the astronomer, who has to measure within a remote spatial system in some far-away region of the firmament, to divide his calculation into two parts. One depends on ordinary processes of astronomical measurement in his observatory, which, if Einstein is right, give results that are dependent on his situation, and are therefore varying. The other part is the application to these results of the tensor equations, which define the fundamental character of the space experienced, and finally yield a concrete outcome enabling the phenomena, as they will actually appear to the telescope when directed from afar in a different space and time system, to be predicted and described with exactness.

The distinction between the space-time manifold itself and the relations which we abstract from it and isolate from each other under the titles of

space and time brings us to a second great conception of Einstein which illustrates the general principle of the relativity of all knowledge to mind as its foundation. For Einstein asks what is the meaning, in the light of what has been said by him of the character of the basic manifold or continuum, of the external universe in which we observe the earth, the sun, moon and stars, and all other bodies. His answer is that the law of gravitation as formulated by Newton fails, both in generality and in precision, as a description of the general and dominant characteristic of this universe. He specifies what he says must be the only possible view as the principle of equivalence. All motion supposed to take place under the pull of gravitational force can equally well be scientifically described as mere inertial motion, without reference to what was taken to be force or pull. If this can be done we get rid at once, not only of the old puzzle about the possibility of action at a distance, but of a number of other perplexities. In order to pass to the wider explanation all we have to do is to remember that it is a mere arbitrary assumption that we, the observers, are stationary. This can never be known to be the case, for rest and motion are purely relative ideas. The earth on which west and is taken as moving curvilinearly round the sun with vast velocity, and as carrying us with it. It is easy to see why the sun seems, as Ptolemy actually thought, to arise in the east and pursue a daily curve over the heads of us who seem to be at rest. It is really we and not the sun that are in motion, though we have assumed ourselves wrongly to be stationary. The result is that the sun appears to be pursuing a path which

is curved and not straight, because of the relationship to the earth's rotation and orbit. The combination, when truly analysed, discloses what is equivalent to velocity in an orbit of the earth itself of a curved form, entailing the consequence that lines of light passing the sun appear in a space that is itself curved. We are constantly, because of our continuous change in position, resolving differently as regards proportions the combined spatial and temporal qualities of the basic fact we apprehend. Thus space and time have different interpretations as the situation of the observer on the earth alters. To the units in which we express our measurements of space and time we give the same names, but their meanings are different. So it is also when we observe the more distant heavenly bodies. The lines of light are curved, not straight. The planets do not move in straight lines under Newton's classical law of inertia, but in various orbits depending for their forms not on any supposed pull of gravitation, but on the relative and changing situations and velocities of us, the observers. We have, in short, each of us our own private space-time system gotten by interpretation from our individual situations. But as these situations are for most purposes practically indistinguishable, so far as the surface of our earth and the observation of objects on it are concerned, no practical question arises in everyday life. It is, in the main, only when we observe phenomena at vast distances, or are concerned with the relations of objects moving at great intervals from us, or with immense velocities, such as those of electrons, that the differences become of vital importance for science. The magnetic field, which extends beyond our earth

throughout the observable universe, presents us everywhere with analogous questions for consideration.

We have thus, as I have said, our own private space-time systems within which the phenomena of the universe vary in their relations of shape and measurement for observers differently situated. It is these relations one set of which, as the outcome of our interpretations, constitutes space and another set time. There is no space or time which has any scientific meaning other than that of relations of phenomena *inter se* to the observer. Space and time derive their everyday reality from them. One of the first hindrances to the grasp of Einstein's doctrine is the idea that he is speaking of only apparent spaces and times that are constructed out of a real space and time existing independently of them. This is wholly wrong. The sole space and the sole time are space and time as they appear to those who observe.

This conclusion seems at first sight to make them merely subjective appearances. But it is not properly so. As I have already pointed out, there is for Einstein a basic reality existing wholly independently of the particular observer, a four-dimensional manifold from which space and time are derived by interpretation. Such an interpretation we are bound to make if we would know as human beings do, and it varies proportionately in relation to the situation and conditions of the observer. But the manifold itself has characteristics which must, just because it is treated as a foundational reality independent of the situation of the observer, be true of every kind of space-time system that is based on it. Motion, whether it is called gravitational or inertial, conforms in quality, as distinguished from measurement and

shape, to the basic laws of activity in the manifold. We get thus a principle which penetrates more deeply into the behaviour of objects in space and time than does Newton's law of gravitation. It is that the action of a particle in the manifold must be the most direct one geodesically—that is according to the character of the manifold as it exists independently of the individual observer. This is obviously what I have called an expression of a tensor nature. For if we pass to the different forms of space and time which at a later stage, when we know the position of the observer, we can estimate by measurement, we find that the paths vary in shape and measurement. We can only apply Einstein's basic law to concrete problems if we take into account the measurements obtained first at the later stage when we have found our observer and determined his position. But in the absence of the basic principle we shall go wrong, because we shall have no means of distinguishing what is only relatively from what is physically absolute.

Thus the physical universe as Newton conceived it turns out to be what it appears only relatively to the kind of knowledge brought to bear. It is a revolutionary conception, and its consequences are far-reaching. One of them is that we can no longer distinguish matter from energy. All matter is simply a form of energy, active or bound up, and we come back to activity in the manifold as the basic fact. It must be added that the tendencies of modern physics appear to have been already in this direction. From the particle science was increasingly turning attention to the field of action within which the particle behaved. Of Einstein's principle it remains to be

observed that, while it appears to be true as according with the observed facts so far as it goes, it has yet to be seen whether it expresses the whole truth. There are already questions about this.

Einstein's doctrine of the relativity of our physical knowledge to the observing mind may thus be said to be a scientific and exact illustration of the wider principle which affirms that in all knowledge the object is determined, in its significance as real, by the conceptions which mind brings to bear in interpreting and giving it meaning. In other departments of the science of nature this is as apparent as it is in mathematical physics. I cannot render my observation of a living organism in terms of causes operating externally to their effects in space or time. The life of the organism consists in the preservation not only of its characteristic form but of its development amid constant change in material. Minute micro-organisms give birth to millions of similar organisms which all inherit behaviour in the same way. This is. scientifically inexplicable as a mere result of fortuitous concourse of atoms, or of action upon each other of molecules accidentally coming together. The reluctance of the older biologists to accept this inference arises from the assumption that all reality is merely mechanical in nature, and that to admit any other view is to interpret life as produced by some external cause of a miraculous character, miraculous in that it cannot be made to harmonise with the only real facts observed in nature. But are the supposed facts the only real facts, or are they the outcome of restricted standpoints which, analogously to the Newtonians, we have imposed on ourselves in such a way as to

limit what observation really discloses? Have we been, in other words, the creatures of conventional and unconscious assumptions? There is an alternative view which would teach us, if accepted, to see in life a set of phenomena at a logically different level in knowledge from that of physical causation, a level at which the interpretation is one, not of the merely mechanical and external relation of cause and effect, but of the fact of behaviour. Now behaviour may be consciously purposive, but we have not necessarily got before us in the bare fact of life conscious purpose. There is apparent on all hands behaviour which is unconscious. Its essence is fulfilment of what I will call an end, and not response as the mere effect of a mechanical cause operating *ab extra*. Let us look at what confronts us in the domain of animal life. The organism pursues a definite course of self-development from conception through birth to death. This development conforms to a course which is marked out in the interest of an end which is more than merely individual, that of the species. It is only in the light of this standpoint that we can state heredity, with the preservation of individual form and capacity from conception to death. The action which guides this seems to be, not, as mechanicians would have it, action at a distance. It is the operative consequence of an end, continuously present and directly manifesting itself in the behaviour of the living being, the life of which depends on the continuous maintenance and development of a definite form due to the self-imposed influence of a particular kind of end. The kind differs in the various forms of animal life. The lower we go the simpler and more uniform

is the resemblance in the behaviour of the individuals that constitute the species. A germ reproduces itself, it may be by fission, and the resulting myriads of germs are indistinguishable in point of conduct. It is only when the freedom of intelligent self-control comes in, as in the cases of the horse or the dog or the human being, that individual variety is markedly established, and the more the phenomena approach the level of such intelligently self-directing freedom, the greater the variety between individuals. That is what observation teaches us. The operation of ends in producing behaviour is everywhere apparent, but among these ends there is difference in their nature. Conscious purpose belongs to a higher level or degree in experience than that of mere end. At neither level is it a cause acting externally, but it is an immediately present end that determines the behaviour of the organism, though at the lower level we have before us life only and not yet consciousness. At the degree in knowledge and reality at which the latter is characteristic the end is the expression of purpose which is largely self-determining and the outcome of freely directed volition. We live as well as know. In merely living we are not free. In knowing and in the execution of purpose directed by knowledge we belong to an order of objects within nature which transcend the ordinary principle of external nature in that they imply a significance which is that of the self-directing and self-recognising subject in knowledge. We find a new set of conceptions here brought into operation in the construction and interpretation of reality at this degree, conceptions which lead us on to personality, and to the larger aspects of our individuali-

ties that take form in society, in the state, in ethics, in art, in religion, in knowledge. But our activities as the expressions of these conceptions are much more than mere happenings or activities in space and time. By an abstraction which he makes for the purpose of getting a sharp picture the psychologist conceives them as such objective activities. For limited purposes this is as legitimate as it is for the physicist and the chemist to measure the structure and the energy of the living organism in such a fashion as to get definite knowledge of certain limited kinds. But neither in their case nor in that of the psychologist is the image so fashioned more than an artificial and inadequate one. Its utility is akin to that of the equations in which the mathematician, by ignoring all other aspects of reality excepting order in series, can extend his knowledge. But his knowledge is always only of a kind which is true as far as it goes, but is incapable of taking account of the inexhaustible riches of the actual which it shuts out. So it is with the psychologist also. His method is only one by which he strips the actual, and, by confining himself to a limited standpoint, transforms its real aspect. He makes intellectual processes into objects in space and time. We can only adequately interpret life and mind in the terms that are appropriate to life and mind, and so it is in ethics, in art, and in religion. They are actual at levels that are their own, and they require for the presentation of these levels their own conceptions and terminologies, and these are implied in their significance and enter into their actuality.

We thus reach a view of experience in which its reality, as well as our knowledge of that reality,

appears as of different kinds and at different levels or stages within experience. The entirety of both knowledge and reality we do not take in completely, because of the finiteness of our minds, a finiteness that arises from these minds being conditioned by the character of the physical organisms in which they express themselves. But thought, which is in its own nature no action in space and time, but is that which gives their significance and actuality to the relations of objects to ourselves as physical existences and among themselves, is itself no event in space and time. Such events it reaches over just because it is their foundation. It is identical in all of us, despite its differences. This is why our thoughts correspond. They are not merely happenings which resemble. They are logical conceptions identical throughout difference. Into each other's sensations we cannot enter. These depend on our individual organisms and exist only in relation to them. But thought is of a different nature. It is concerned with the universal, that which is the identical for all of us, however the particulars it fashions and gives setting to may vary. This is what is implied when we say that we all see the same sun, moon, and stars. However private and particular the sensations transmitted through our respective optic nerves may be, we place on these sensations a common interpretation, and so construct the common experience, identical really only in the universals which are signified in recognition. It is in its universals, the thought in which we think the objects, that the identity of their significance and therefore the sameness of their reality lie.

We may now realise what we mean when we speak

of our individual experience as an entirety which we regard as singular or unique. It concerns our special and private existences as living and intelligent organisms dependent on our senses. To these individual aspects of knowledge, implying as they do private sensations and feelings, experience always refers. But it imports more than this. It arises and is real only in so far as we know as well as feel. It is indeed only by abstraction that we separate the general knowledge implied from the feeling; the permanent universals which are ambiguous and of a merely general form, inasmuch as they describe only classes, from what is particular and fleeting. But knowledge is in its full nature more than can be represented by either set of these abstractions. It is a concrete whole within which all that we distinguish falls as inseverable, a whole in which every aspect is included. Only by abstraction can we take our knowledge to be an instrument standing by itself, as it is made by the psychologist to do. Subject and object are only relatively distinguishable within it, and then merely for special purposes and from standpoints that are limited. The self in knowledge is no mere object even for itself. It is always more than this. It is a centre to which all reflection refers, the activity of reflection which alone gives meaning and coherence to its object world and is the basis and condition of its existence. We make ourselves objects only when we think of ourselves as having places in space and time. But we find that space and time themselves, and all the objects that fall within them, including the self when so regarded, are there, present, past, and future, only in relation to the self that holds them together and in unison. The

essential character of this self is to be subject for which the object, and the present, past, and future, are there and are significant. The self reaches over all objects. It is aware of and establishes its own limitations, for it finds that even these owe their existence to reflection. Subject and object thus disclose themselves as aspects falling within a single entirety, differentiated only by the standpoints from which we approach them. An entirety is implied at the points at which both are transcended and embraced, and that entirety is just the final fact that we know, and that to knowledge no distinction is impenetrable just because every such distinction is itself but the creature of knowledge.

It is in this sense that knowledge is related to experience as the foundational and ultimate reality within which the whole of the individual experiences of the mind fall. It is for this reason that when we know we are always more than we take ourselves to be. It is to relativity in standpoint that we owe the view that we are no more than individual human beings that walk in the streets and are describable in terms of mere life and private happenings. It is from this degree and sense of relativity that we are delivered by the conceptions belonging to knowledge at higher levels which we meet in duty, in art, and in religion, and these indicate yet higher standpoints at which the finiteness of existence presents itself as such only because of limitations in outlook to which our position and history in nature confine us. Such limitations we pass beyond when we assert the presence of the higher reality that is their foundation, and so illustrate the power of thought to overcome obstacles which are its own creatures.

We thus come to the true character of knowledge. It is in its essence obviously neither merely general nor merely particular, for the distinction between these two aspects is a distinction established by and within knowledge. The true character of knowledge seems to be what has been called the concrete universal. The expression means that, whatever its form, there enter into knowledge moments or factors, particular as well as general, which have nevertheless no independent existence, but express in the concrete unity in which alone they are real the aspects of particularity and generality. Even when I try to proceed to particularity in its extreme suggestion, and point with my finger to what I call 'this,' the general or universal aspect is forced on my consciousness. What is 'this' at the moment becomes 'that' as the moment passes, and the coming moment brings a new 'this.' Such relations, from their very character, cannot be particular objects. They signify in truth references to the subject in knowledge, and they are the expressions, not of self-contained events in space and time, but of conceptions brought to bear in our thinking, which give reality to particulars with which reflection is concerned. They are thus of a nature which is of general application. They are what logicians call universals. But not the less there is no 'this' which must not combine with its general character some particular aspect or moment in its constitution. If it is a universal it is a concrete universal in the sense that its reality always implies the particular. That reality is thus a significant fact from which, by making abstractions, we can deduce both of the aspects implied in it. But it is only in the integral

form of the actual unique and unambiguous fact that these aspects have reality in an object world. It is in reflection, and reflection alone, that universal and particular are dissociable. That is what we mean when we speak of the concrete universal, and designate it as the form which the object of knowledge must always assume. Even when we reason most generally, as in mathematics or metaphysics, we always have to fashion for ourselves images and use metaphors. The reason is the necessity of the essential moment in knowledge of the particular. But when even a dog sees a wasp crawling on the ground near his nose, he seems to proceed to study and to classify it through universals as a member of a noxious species which must be treated with caution.

All knowledge is particular as well as general, and when it is supposed to be dealing with the most abstract universals it is really making use of particular symbols or images in which they are realised. On the other hand, every son of Adam and all animals that rise above merely instinctive action seem to employ universals in some form. When a man pulls on his boots he uses the conceptions of physics; when a horse feeds he recognises a general coincidence between the satisfaction of the feeling of hunger in his stomach with the consumption of enough corn.

Put in other words, the actual is of a character neither general nor particular, but singular or individual. It is this singularity that renders it unambiguous and what is called *unique*, significant just of one self-contained existence, different from every other in the universe, and of that alone. But this uniqueness is itself only possible in that the general and the particular both enter into its logical com-

position. It requires the former for its meaning and nature. It requires the latter in order to enter as an individual form of living experience. Every object thus presupposes the fact of knowledge as its foundation, for in knowledge alone do these two aspects come together in unison and as an entirety. All knowledge is, therefore, as much concrete as it is abstract. For the real with which it is concerned, and to which it gives the meaning apart from which no object could be spoken of as existing, implies both aspects.

In all experience sensations, images, and metaphors are invested with significance. This depends for its reality on interpretation through universals, which give their meaning and not less their actuality to the apparent particulars to which they are applied. For it is only within the entirety that is characteristic of knowledge that this actuality has meaning. It may be the actuality of an erroneous idea. For truth and error, reality and unreality, righteousness and sin, beauty and ugliness, and all else that is distinguished, get meaning only within knowledge. It is only for knowledge that they are existent. Our hesitation about accepting this view arises from our uncritical use of images and metaphors. We think and speak of knowledge as though it were a relation between two independently subsisting objects, a property of a self conceived as a kind of self-contained thing in space and time. But this cannot be an adequate view, for it is only by presupposing what is in its implications the entire system of knowledge that we can come to this conception itself. Knowledge is indeed no activity of anything else. It is the foundational reality into which and in terms of which alone

our universe, without and within, can be resolved. If we may use the dubious word 'absolute,' it is the absolute to which all else is relative. It is because for our own working purposes we have formed a distorted picture of knowledge that we hesitate before accepting this obvious fact. I may and must speak of *my* knowledge, that of a finite self conceived as falling within the object world. For everyday purposes it is inevitable that I should do so. But the expression is no exhaustive one, for the simple reason that the standpoint from which it is employed is not the only conceivable standpoint nor adequate to the full reality. If I would get at the underlying nature of the universe I must therefore subject it to analysis, not wholly dissimilar from the analysis to which Einstein found himself driven when he set himself to determine the meaning of shapes and measurements in space and time, and to discover true invariants.

I have now completed the examination, so far as is needed for my purpose, of the character of ultimate reality, and have to a certain extent made an explanation of the significance of the expression 'concrete universal.' I can accordingly, before very long, pass from the abstract physics and metaphysics that had to be referred to in the first place, towards the extension of their underlying principle to that other and humanistic side of knowledge which is most concerned with the aspects it presents under forms which we call feeling and emotion.

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM (*continued*)

CHAPTER II

THE TRANSITION TO HUMANISM

In the first of these chapters I stated certain reasons that made me think of the object in every kind of knowledge as being what I called a concrete universal, an unambiguous and unique fact of an individual character. It was suggested that this must be the actual form of every object of knowledge, whether of knowledge which we treat as being of an abstract character or of knowledge which we regard as particular, for example in our barest awareness of feeling. We never really think in purely general abstractions. We always form images which are symbolic of possible particular cases included, but indicate a class determined by general predicates with which our immediate purposes are concerned. The dynamic character of thought causes us to do this. On the other hand into the barest passive awareness there enter characteristics of universal character through which we have to distinguish and classify. Feeling is fraught with thought and thought with feeling, and we discover finally that each, taken in isolation, is an abstraction with no actuality independent of the other. The only reality is what contains both in integral unity, the unambiguous and unique concrete universal, which is so called because it is felt as well as thought, and is the fusion of these moments,

unreal in independence, in an object which is in our experience just itself. For it is particular as much as it is universal, inasmuch as it is just this and no other object, and as such is self-contained. It is what the Germans name *eindeutig*. It means only just this one particular fact in the universe, and is unequivocal.

Of course we can never exhaustively describe a concrete universal. The process would imply, for the completion of its general aspects, reference to relations to all else in the universe, and would be infinite in its extent. It would, on the other hand, suggest an asymptotic approach to the elusive pure particular, and a denial of the reliability of knowledge itself. But no consistent scepticism has ever been able to reach the pure particular. The inconsistent unconscious assumptions involved in the attempt to do so have always ruined pure scepticism, and always must. On the other hand, describe the concrete universal exhaustively in general terms we cannot. It imports more than what is general and therefore ambiguous, as being applicable indifferently to all or any within its scope, in that the universal defines only a class and not the individual member of the class to reach which we always seek. Even when we point with the finger and say 'this' we have only indicated in terms of a universal what an instant later is true of something else, and therefore indicates what is equivocal and not unique. 'This' passes into 'that'; 'now' into 'then.' It is in the nature of thinking that it should be so. Much mystery has been made over what the Greeks quite naturally called the dialectical character of thinking. This name is a mere description of what we observe if we let our thought alone and watch it developing itself.

We see, if we do so, that it is dynamic and not static, and presents itself in that form.

The merely particular, stripped of the universals in which it is set in our experience, neither means nor is anything for us. The merely universal, divorced from the particulars to which it gives their setting in experience while leaving the result a unique and individual fact for observation, is a mere unreal abstraction apart from the particulars to which it is thus essentially related. The unique individual fact in experience, just because of the dynamic or dialectical character of the thought that so sets it, is always breaking out into further and new relations which give to experience its continuity. Both aspects, that of the universal which is equivocal, and that of the particular which is in itself a mere disappearing point of application, are essential, if the fact of the actual is to be recognised. It is for this reason that generality and uniqueness, continuity and discretion, necessarily imply each other in nature. That is, in effect, saying that the character of the real is to be a concrete universal.

If this be so consequences follow on which I shall not dwell in detail here, for I have devoted a good deal of space to them elsewhere, in the book already referred to. The ultimate form, the foundational fact in our experience, is the concrete universal, the unique and unambiguous individuality in which the actual is always finally self-presenting. This is so in daily life as much as in abstract science, and it is so because this form of individuality is foundational in all knowledge when freed from the relativity we impose on it. We seem to be here contemplating mind as having for its essence free-

dom and self-direction. For we are taking it at a level at which it is not confined by the abstractions of physics, and at which the category of a cause and effect external to one another is inadequate. With mind as we are now expressing its nature, driven to do so by the demands of reflection, to think and to create are not in ultimate analysis essentially different activities. For all falls within the whole, the entirety that is mind within which the universe, including all distinctions made within it, falls, its object world existent through the intelligence from which that world is inseparable, an intelligence which is always more than it takes itself to be.

Should this conception prove well founded it furnishes a new light on the significance for us of the universe itself. We begin with the fact, the expression of which we find in what is nearest to us, our direct experience, the fact of the concrete universal into which both thinking and feeling enter for finite or conditioned reflection, and, starting from this fact, thought proceeds to make abstractions. Such abstractions yield only the general notions which ascertain general classes as distinguished from individuals, and in the end are therefore ambiguous in their guidance for ascertaining facts. But, if thus ambiguous, they are potent in eliminating what is irrelevant to the purpose in hand. They enable us to concentrate and even to extend knowledge, as does the mathematician by developing the implications of his symbols. These symbols are in reality metaphorical. Because they are in a sense ‘ things ’ we can operate with them and form new combinations in space and time, images from which we can make further useful abstractions and

deductions of what is implicit in them. But symbols only they are, inadequate as descriptions of the full reality the concrete aspects of which they shut out.

It is in this fashion that we start from the actual that is the foundational fact of reality. We begin with what is in the highest degree concrete, and the inherent activity of thought is ever establishing distinctions, themselves of the nature of abstractions. Our commencement is with what is most free from the fission between universal and particular, which reflection is ever establishing in an increasing degree. We make abstractions under the guiding concepts which the dialectic of reflection sets up. Starting from mind as free we work downwards to the external world which seems to come to us through our sensations, and relatively speaking does so in our history as self-presented objects in space and time. But it is only because the entire system of knowledge is implied as potentially present throughout that we can so interpret. We work in truth from what is above and concrete to what is below and more abstract. We find in our experience what suggests such conceptions as freedom, mind, life, causation. Going further in reflection, we can limit ourselves, as does the pure mathematician, to mere order of series in externality. But we can also employ, as not less suggested for definition by the actual, conceptions like those of value, as in art and in religion. Thus we find that the universe displays its actuality from many standpoints, and that these standpoints give us distinct forms at different levels, not only of knowledge but of reality. The standpoints are moulded by the categories the mind in

its freedom of purpose selects, and they give rise to degrees or levels in knowledge and reality which constitute a hierarchy within the all-embracing fact of mind. That is the ground principle to which the history of thought has pointed since the days of Plato and Aristotle, and which seems to me to be pointed to in our own time not only by philosophy but not less by modern science. The real is what it is because it is in ultimate analysis relative to knowledge, and it has many forms because knowledge has many levels. What is actual fact thus presents many aspects. The living organism is a mechanism from the standpoint of the physicist and the chemist, a useful and essential standpoint. But this is yet only a partial standpoint which yields no more than an aspect in which the real here presents itself. The aspect in which that real is living is a different aspect that cannot be reduced to or rendered in terms of the first. It belongs to a different order in knowledge. But that order is more comprehensive and adequate in furnishing a level from which we can generalise about what we actually observe and dare not ignore if we would reach full truth. It is the duty of the philosopher to ask the man of science, who claims to be an accurate observer of nature, to remember the need of care in choosing the conceptions under which he brings what he observes, and to bear in mind the possibly distorting effects of these conceptions on the images and metaphors he uses.

It is the glory of science to establish general principles and to exhibit order in sequence. But this it does at a sacrifice. It is not only the mathematician who has to make abstraction from other

phases of the actual. The biologist does so also. What does he tell us of the minute micro-organism? Only that in living it exhibits the characteristics of its field, the self-conduct of the species. Of its individuality—for it may possess individuality—our methods enable us to take but little cognisance. We shut this out, as does the statistician in his abstract investigation of human beings. What the difference between individual micro-organisms may be, whether they possess any form of mind or freedom, we are not quite certain. The methods of the future may be able to tell us these things. The methods of to-day do not. They are based on conceptions which exclude the practicability of such an inquiry. Biology and physiology are, like mathematics, abstract sciences, although they make their abstractions in a different fashion and under the guidance of different concepts.

I turn again to the nature of experience as indicated, not only by what in daily life we encounter, but by the considerations I have dwelt on. What we are aware of is always what is individual and self-contained, although we may not always approach it from this point of view. But even its individuality and self-containedness subsist in virtue of relations, general characteristics, which do not themselves possess the quality of singularity. Yet apart from this quality that of which we are aware would have no meaning and so no reality. The real is always individual, and on that account the logical moment of particularity must enter into it. General and particular are derivatives from concrete actuality through the abstractive tendency of knowledge to define in terms that apply not to one but to

any of a class of individuals. But first in order of thought as well as of fact comes the unambiguous singular from which we start, and this is always characterised by the moment of particularity that enters into and is inseparable from its being. It gives it, as I have already observed, what the Germans call its *Eindeutigkeit.* The quality appears in every form of direct knowledge. We regard our sensations and emotions as individual, although we cannot define them without some recognition of the class to which they belong—in other words, by directing reflection to the relations in which they always subsist. So it is with the various objects in a landscape; they are always individual in just the same fashion. So with the apparently infinitesimal aspects of nature. They may be ultra-microscopic, but they never appear to be merely of a continuous or general nature. We always have to aim at fixing them as individual in some sense. Our ideas of them as such may be merely limiting ideas, but the character of experience forces them on us. This is because of the fundamental character of all knowledge. The universality that appears in it is always, for the reasons assigned, concrete—that is to say, of individual form. This is why, even when we try to think most abstractly, we find ourselves, like the pure mathematician, unable to do without images and symbols and metaphors. It may be that this is what is fundamental in what seems to force itself on us in accordance with the *quantum* theory in modern physics. The exclusive stress laid on continuity in Newtonian dynamics appears to have deflected observation from an equally real characteristic of the actual before it, its character

of being discrete not less than it is continuous. The solution of the problems which the facts disclosed by the sciences of light, heat, and electricity in their most modern forms are now pressing on us may turn out to require resort to the ultimate character of our knowledge for their complete interpretation. It may be that it is necessary to penetrate as deeply as only epistemology can in order to reconcile apparently conflicting appearances.

But, however it may be with physical science, when we get to our observation of mankind we are left in no doubt. What is it that we call *character* in individual men, and why do we esteem it? It stands for us as a highly distinctive quality in him who possesses it. It means that he is a man standing out among other men and incapable of being confused with other individuals. A man may be clever, he may be eloquent, he may be good, but none of these attributes mark him out as just this one person who is unmistakable, and who exists for us as being different from all his fellows. For the qualities to which I refer are general qualities in which an indefinite number of others may share. They are not in themselves enough to render the possessor unique. He is this in virtue of his personality, which implies what is peculiar to himself. The elusive and indefinable moment of the particular enters into it. General qualities or particularism may either of them preponderate in the individuality of the man. He may be so dominated by particularism as to be hopelessly ignorant, or unfit for society, or a criminal. But the particularism which marks him off when sufficiently prominent goes to the making of a higher individuality when

fused with general ability or moral quality. We cannot therefore estimate men by merely abstract standards. These are invaluable and indispensable in the task. But they are not everything. The instinct of the man-in-the-street comes in to play its part. This, again, is not everything. It may clash with abstract estimation from a much wider point of view. It may in itself prove insufficient and misleading. But it belongs to the nature of human knowledge that a so-called instinct, which as it were intuitively lays stress on the moment of the particular in reality, must have account taken of it. That is why, in order to make a leader of men, various and diverse qualifications are requisite. A man may possess one-sided qualities in a degree that entitles him to be distinguished as great by their possession. But he will hardly lead men unless he possesses, in addition, other qualities which can appeal to the direct apprehension of the mass of his fellow-men. A great American statesman once declared to me, as the result of long observation, that he believed the really essential gift of a national leader to be the power to persuade.

I do not mean to suggest that this capacity for recognition as leader of necessity imports the highest quality. All knowledge and all the higher capacities are essentially of a more remote kind. They require a concentration amounting to passion which may shut out the vision of all to which it is not directed. Browning's 'Grammarian' was of this type. In mundane affairs he was a weak man, and yet the people saw that, measured by standards of value of a great kind, his quality was of the highest order, and they reverenced him accordingly. They would

not have chosen him to lead in battle or as Prime Minister, but they saw and said that he was great. That was because they recognised his knowledge, though abstract knowledge, as being of a lofty type.

This brings me to what is, I think, really meant when the critic uses the word 'Humanism.' It imports what is more than merely general, individual uniqueness based no doubt on particularism, but on particularism invested with high quality of general human interest which shapes it into a whole. The uniqueness may be of the most divergent kinds. But its freedom from abstractness within the order to which it belongs stamps it with a directness and perfection that gives the full sense of reality. It implies nothing short of conceptions which import human personality. In poetry we look for and find this quality, as we do in Wordsworth and in Goethe's lyrics. We find the same sort of quality in individual form in the ancients, what is suggested in, for example, the well-known description in Virgil:

"Tendebantque manus, ripæ ulterioris amore."

We find it in the domain of religion in the sayings of Jesus. We find it in public life in the penetrating words of really great orators, and in art in the works of very great painters and sculptors. We meet it in Beethoven's Sonatas, and in the work of musicians who give us the sense of what we cannot even in imagination pass beyond. In all these cases there is ever present as the essential moment an element of quality of a high order in reflection. This is of the character of the universal, and it therefore lifts us above the moment. We feel that we are put to a great test by the question whether we dare say to

that moment, 'Stay, thou art fair.' The test brings us face to face with the necessity for a decision about value, about the true nature of the eternal, and for the rejection of the appearance of attractive but false finality.

The standard of the universal that thus enters compels us to recognise that, as knowledge itself is ultimately foundational of reality, so in our daily practice it assumes the form of values that are foundational. They are this because when they are really present we cannot go behind them. We are aware that they are presupposed in every attempt to set up the other standards that are in truth of a derivative nature. That is why the doctrine of Hedonism has been a failure. If pleasure is to be of lasting value it must always in the end be distinguished, even when it possesses uniqueness, by quality. And if the test of quality is once admitted, what we have so admitted may imply a nature going beyond the moment, and belonging to the universals that lie at the foundations of the actual itself.

Everywhere we experience in what is unique in its concreteness the inseparability of the particular and transitory from the universal that abides through it and gives it meaning. In values, and in the inevitable preferences between orders of quality that disclose themselves at every turn, we are face to face with this in our daily lives. It is more than an abstract preference for a general rule that makes men accept high quality in value, while for want of such a standard the mere animal cannot get beyond the passing feeling:

> "Poor vaunt of life indeed,
> Were man but formed to feed

On joy, to solely seek and find and feast,
Such feasting ended, then
As sure an end to men;
Irks care the crop-full bird? Frets doubt the
Maw-crammed beast?"

On the other hand:

"Let us not always say,
'Spite of this flesh to-day
I strove, made head, gained ground
Upon the whole!'
As the bird wings and sings
Let us cry, 'All good things
Are ours, nor soul helps flesh more now
Than flesh helps soul!'"

In lines such as these we have the reflective poet coming to reinforce a theoretical conclusion. In what Browning says in them we have a feature which is distinctive in Humanism. Even when our intellects reject on general grounds the suggestions of a poem, or of what some particular religious doctrine seeks to insist on, we may yet be aware of quality high in other aspects, and esteem what is written accordingly. It may be here value of a different kind from what belongs to science or philosophy that we are aware of, and it may belong to a different order in reflection. The standpoint is not the same as it would be for science, but not the less it guides us in an appreciation of the value that is appropriate to its own order of ideas—ideas which enter into individuality, its finiteness notwithstanding, and are inseparable from that individuality. I will take two widely divergent descriptions given by great writers as illustrative of this kind of relative truth, truth of a humanistic kind, in which the insepara-bility of the particular from the general is insisted

on. The first of these illustrations is concerned with a movement that, in the sense in which I am using the word 'Humanism,' was intensely of this character and was distinguished by its refusal to bow before the merely abstract side of knowledge.

We are beginning to forget the Oxford Movement in the Church of England between 1833 and 1845. Yet it formed a splendid passage in the history of the national life, notwithstanding its failure, which we now see clearly to have been inevitable. The picture is one which has always deeply moved me as an illustration of Humanism in a very lofty form. We of this generation are fortunate enough to have had that picture presented to us, not merely in contemporary records, but by an historian as gifted as was Dean Church, who combined artistic skill with deeply sympathetic insight. This is what he tells us of the Oxford Movement, at p. 167 of his book on it, which I quote to introduce what follows:

"The Movement was, above all, a moral one; it was nothing, allowed to be nothing, if it was not this. Seriousness, reverence, the fear of insincere words and unsound professions, were essential in the character, which alone it would tolerate in those who made common cause with it. Its ethical tendency was shown in two things, which were characteristic of it. One was the increased care for the Gospels, and study of them, compared with other parts of the Bible. Evangelical theology had dwelt upon the work of Christ, and laid comparatively little stress on His example, or the picture left us of His Personality and Life. It regarded the Epistles of St. Paul as the last word of the Gospel message.

People who can recall the popular teaching, which was spoken of then as 'sound' and 'faithful,' and 'preaching Christ,' can remember how the Epistles were ransacked for texts to prove the 'sufficiency of Scripture' or 'the right of private judgment,' or the distinction between justification and sanctification, while the Gospel narrative was imperfectly studied and was felt to be much less interesting. The Movement made a great change. The great Name stood no longer for an abstract symbol of doctrine, but for a living Master who could teach as well as save. And, not forgetting whither He had gone and what He was, the readers of Scripture now sought Him eagerly in those sacred records, where we can almost see and hear His going in and out among them. It was a change in the look and use of Scripture, which some can still look back to as an epoch in their religious history."

From the point of view of literature and philosophy alike the greatest figure in the Movement, of which Dean Church thus characterises the essence, was that of John Henry, Cardinal Newman. He failed to succeed, as he was bound to fail. The Spirit of God and man was too great to be confined within the limits which he assigned. But, none the less, he stands out as one of the great Humanists of English literature, a man with an almost matchless sense both of form and of reality. I will therefore quote from *The British Critic* of April, 1839, some words from an article of his on the state of religious parties, directed to the question of what the Movement of which he was the leader meant.[1] He

[1] This article is reprinted in vol. i of Newman's *Essays, Critical and Historical*, p. 271.

would not tolerate the view that the influence of that Movement was merely due to the energetic action of a few individuals.

"Of course every event in human affairs has a beginning; and a beginning implies a when, and a where, and a by whom, and how. But, except in these necessary circumstances, the phenomenon in question is in a manner quite independent of things visible and historical. It is not here or there; it has no progress, no causes, no fortunes; it is not a movement, it is a spirit; it is a spirit afloat, neither 'in the secret chambers' nor 'in the desert,' but everywhere. It is within us, arising up in the heart where it was least expected, and working its way, though not in secret, yet so subtly and impalpably, as hardly to admit of precaution or encounter on any ordinary human rules of opposition. It is an adversary in the air, a something one and entire, a whole wherever it is, unapproachable and incapable of being grasped, as being the result of causes far deeper than political or other visible agencies, the spiritual awakening of spiritual wants."

A noble description this of the humanistic spirit, indicative of the compelling character of the individuality and particularism of the concrete universal and of the uniqueness that belongs to it.

I will pass to a very different illustration, selected for the purpose of bringing out the antithesis between concrete and abstract. The German metaphysician Hegel is often smiled at as an authority on such a matter by people who know about him only at second-hand, and to quote him excites as much repugnance with some as to cite Cardinal Newman does with others. I must not be deterred by prejudice

in either instance. My object is to select illustrations of the most useful kind.

Among other essays which Hegel left behind, and which are collected in volume xvii of his collected works (the second volume of the *Vermischte Schriften*), is an essay entitled, "Who is the Man who thinks Abstractly?" He begins by observing that no one is so great a bore as he who is always trying to *explain* everything in the beautiful world in which we live. It is because we have a fine sense of what such abstract explanations amount to, and because we do not want them, that we flee before them. But, although in polite society we assume that we avoid what is abstract, we sometimes fail. The question remains, who are the people with really abstract minds? They are, says Hegel, for the most part, the less educated; not the most educated. Yet not always. He takes, as an illustration, what happened at an execution in Leipsic, where a man was broken on the wheel and then beheaded, for the crime of murder. In what follows I have used the translation given by the late Professor Wallace, in chapter xx of his *Prolegomena*, not of the whole essay, but of a passage containing Hegel's description of what took place:

"In the eyes of the multitude he is a murderer, and nothing more. The ladies, perhaps, may make the remark that he is a strong, handsome, and interesting man. At such a remark the populace is horrified. 'What! A murderer handsome? Can anybody's mind be so low as to call a murderer handsome? You must be little better yourselves.' And perhaps a priest who sees into the heart, and knows the reasons of things, will point to this remark

as evidence of the corruption prevailing among the upper classes. A student of character, again, inquires into the antecedents of the criminal's upbringing; he finds that he owes his existence to ill-assorted parents; or he discovers that this man has suffered severely for some trifling offence, and cannot support himself otherwise than by crime. No doubt there will be people who, when they hear this explanation, will say, 'Does this person, then, mean to excuse the murderer?' In my youth I remember hearing a city magistrate complain that book-writers were going too far, and trying to root out Christianity and good morals altogether. Someone, it appeared, had written a defence of suicide. It was horrible! too horrible! On further inquiry it turned out that the book in question was the *Sorrows of Werther*.

"By abstract thinking, then, is meant that in the murderer we see nothing but the simple fact that he is a murderer, and by this single quality annihilate all the human nature which is in him. The polished and sentimental world of Leipsic thought otherwise. They threw their bouquets, and twined their flowers round the wheel and the criminal who was fastened to it. But this also is the opposite pole of abstraction. It was in a different strain that I heard a poor old woman, an inmate of the workhouse, rise above the abstraction of the murderer. The sun shone, as the severed head was laid upon the scaffold. 'How finely,' said the woman, 'does God's gracious sun lighten up Binder's head!' We often say of a poor creature who excites our anger that he is not worth the sun shining on him. That woman saw that the murderer's head was in the sunlight, and that it had not become worthless. She raised

him from the punishment of the scaffold into the sunlit grace of God. It was not by wreaths of violets or by sentimental fancies that she brought about the reconciliation; she saw him in the sun above received into grace."

In the preface which he wrote to his edition of Wordsworth's poems Matthew Arnold, who had a firm grasp of the meaning of the humanistic element, dwells on the inseparability from it of high knowledge: "The noble and profound application of ideas to life is the most essential part of poetic greatness." It is worth noting, this opinion of a competent critic, because it appears by no means clear that his standard is receiving full recognition in the poetry of the present day. He goes on to observe that a great poet receives his distinctive character of superiority from his application, under the conditions inevitably fixed by the laws of poetic beauty and poetic truth, to the subject, whatever it may be, of the ideas

"On man, on nature, and on human life,"

which he has acquired for himself. But the treatment of large ideas, say moral ideas, in a poem is a very different thing from the composition of a moral and didactic poem, which can bring us 'but a very little way in poetry.' Moral ideas are really a main element in life, and therefore are that with which, in some way or other, we are as human beings perpetually occupied. A large sense belongs to the expression when thus applied to the subject matter of poetry. Whatever bears upon the question 'how to live' comes under it. Thus, when Milton says—

> "Nor love thy life, nor hate; but, what thou liv'st,
> Live well; how long or short, permit to Heaven,"

these are noble words of a great artist. But not the less does Keats express a moral idea when he consoles the forward-bending lover on the Grecian Urn, the lover arrested and presented in immortal relief by the sculptor's hand before he can kiss, with the line:

> "For ever wilt thou love and she be fair."

So when Shakespeare tells us that—

> "We are such stuff
> As dreams are made of, and our little life
> Is rounded with a sleep."

All these three examples are, for Arnold, examples of true poetry. For what they present is no abstract or general moral lesson but universal truth, in concrete and individual form, in its union with the uniqueness that is of the essence of our experience of life. And so, whatever else such poetry may be, it is conspicuously humanistic. Wordsworth's own great power lay in the largeness of his outlook and in his ability to find more in life than other poets. Add this to his artistic faculty, and you have the secret of his superiority to other poets. "He dealt with *life*," says Arnold, "as a whole more powerfully." He goes on to warn us against the 'Wordsworthians' who hold up Wordsworth's poetry as precious because of its 'sound philosophy.' An illusion. They praise him for the wrong thing. "His poetry is the reality; his philosophy—in so far at least as it may put on the form and habit of 'a scientific system of thought,' and the more it puts them on—

is the illusion." Arnold dismisses the formal philosophy which appears as such in Wordsworth, and thinks that "poetry is the reality, philosophy the illusion." I do not differ from him if he means, as I think he really does, that the universal by itself is wholly inadequate to reality, and is actual only in the individual. But then, for full insight into the individual, we require the mind that can think in universals, and of this there is no more conspicuous proof than the advantage Arnold himself possessed over most contemporary critics of poetry. When he tells us of the power with which Wordsworth feels the joy offered to us in nature and in the primary affections and duties, however simple, he couples his comment with one on the extraordinary power which Wordsworth displays in showing us this joy, and in so rendering it as to make us share it. "Everyone," he says, referring to other poets, "who has any sense for these things feels the subtle turn, the heightening, which is given to a poet's verse by his genius for style. We can feel it in the—

'After life's fitful fever he sleeps well.'"

And in the case of Milton he declares that it is the "incomparable charm of Milton's power of poetic style which gives such worth to *Paradise Regained* and makes a great poem of a work in which Milton's imagination did not soar high." If Wordsworth himself did great things with what was often no more than a 'nobly plain manner,' we must notice that Wordsworth's use of that manner has something unique and unmistakable. Nature seems to take the pen out of his hand, and to write for him with

her own bare, sheer, penetrating power. That is due to the profound sincereness with which he feels his subject, and to the profoundly sincere and natural character of the subject itself. "The right sort of verse to choose from Wordsworth, if we are to seize his true and most characteristic form of expression, is a line like this from 'Michael':

'And never lifted up a single stone.'

There is nothing subtle in it, no heightening, no study of poetic style, strictly so called, at all; yet it is expression of the highest and most truly expressive kind." There is, for Arnold, in Wordsworth an *inevitableness* which was often lacking in Goethe, though in him too we sometimes find it, for it comes to Wordsworth from Nature herself.

None the less I think it must be added that the beauty of Wordsworth's poetry is a beauty born of the mind, and born of the mind not the less because that mind is no factory of abstract universals but produces through the creative imagination of genius descriptions of what is individual and unique.

Even for the greatest masters of art the combination of the universal with the particular is often too difficult. Excessive stress is laid on one moment or the other in the reality from which they are inseparable. But it is not only in art that we find this difficulty. In these Islands we are perhaps stronger than many on the Continent in our steadfast refusal to dissociate the two moments, and to fall in particular into the sin of the abstract mind. Yet insistence on the aspect of the particular often brings troubles for us. Those in Ireland know that. There is much of the dynamic in their outlook on life. In the Anglo-Saxon portion

of the geographical area there is less, perhaps too little. But, as a group of nations, we have succeeded in producing what the common denominator of the general genius tends to yield. Even in philosophy this is so. Where can we wish for better examples of this than in plain John Locke, whose Humanism is manifest in a style consistently inspired by his declaration that "God has not been so sparing to men as to make them two-legged creatures, and left it to Aristotle to make them rational." In the Bishop of Cloyne we have the same spirit. With Berkeley philosophy was always literature, and literature not less philosophy. And I must not forget the David Hume whose ashes repose in the Calton burying-ground of Edinburgh. Of all thinkers he had perhaps the greatest gift for putting universals into concrete form.

Philosophy and literature differ less than is popularly imagined in their purposes and methods. Both seek to bring us to awareness of what is most real. The level in each ought therefore to be of high quality. For the philosopher knowledge has to be approached more abstractly than by the artist, just for the same reason as prevails for the mathematician. It is a general form that is with the abstract thinker essential if he is to so express himself as to be intelligible. But no more than the artist dare he break away from the particularity of what is actual. If he fails in self-restraint in this he suffers. If he succeeds he may be himself ranked as an artist, as Plato has been. The best critics have seen the point very clearly. I have already cited as a witness Matthew Arnold.

I will conclude by citing another very highly

endowed critic, Sainte-Beuve, who tells us the same thing in different language. I will quote from the address he delivered in 1858 to the students of the École Normale on "Literary Tradition," with the purpose, as he himself tells us, of illustrating the difference between the duties of a critic and those of a professor. On the authority of Pericles, in his funeral oration over the warriors who had died for Athens, Sainte-Beuve describes it as a city where no chagrins, no jealousies, no rigid austerities offended the eye or mortified a neighbour's pleasure; where it was a joy merely to live, to breathe, to walk abroad, and where the mere beauty of buildings and public edifices, the beauty of daylight and a certain air of festivity, drove sadness far from the mind; where it was possible to love beauty with simplicity of life and philosophy without being effeminate; where wealth was used for a practical purpose, and not for ostentation; where courage was not blind, like that of the furious Mars, but enlightened and knowing its own reasons, as befitted the city of Minerva. An exaggerated description no doubt of Athens even as Pericles made it, but a description of the place of a people who had come to embody its life in the proportions of the real concrete universal. Of Pericles himself, to whom he attributes the guidance which resulted in this disposition, Sainte-Beuve says that he was the most noble and brilliant type of the popular chief, the man who becomes dictator of a democracy by reason, eloquence, talent, and continual persuasion.

Sainte-Beuve goes on to a later epoch when "Biblical grandeur and Hellenic beauty met and were fused and mingled, in spirit and in form, with lofty

simplicity." For him it is this fusion which created at all events a tradition. The real product of this tradition he finds in Shakespeare, who had learned it, he thinks, from Montaigne and Plutarch.

For his general thesis he invokes the witness of Goethe, in whom he says that all tradition united, but that from a literary point of view the classical predominated. Greece taught him to so contemplate the universe that it might appear in its most beautiful light. "As for himself, whenever we wish to form an image of the critical spirit at its highest point of intelligence and of considered understanding, we figure him to ourselves as an attentive and watchful spectator, curious from afar off, on the outlook for every discovery, for all that goes by, for every sail on the horizon—but from the heights of his Sunium."

Yet nobody, goes on the great French critic, has any right to rest quiet, even in the best established admirations. "One thing or another is constantly moving as we watch it, and there open, as in the old cities, long new vistas which change the most familiar views. Instruction is bound, whether it will or not, to take fresh bearings, to reconsider in these things. There are ways also in which it can renew itself, in which it can modify the manner in which it does service to taste and defends tradition." This we may fully recognise while taking care that "the old method, and what has sprung from it, shall remain in honour, an object of worship and of study, present to the memory and to the meditation of those faithful intellects which can still be touched by the idea of beauty."

A fine description this of what we as Humanists should set before our minds. Our criticism must

be based on reflection if it is not to miss what is greatest, and to fail to recognise that in its very relativity to the standpoint of its time has lain its truth and reality. For such relativity applies in the case of the standards of beauty just as it does in those of science. Knowledge never stands still in any form. Its accuracy depends on its power of adjustment in form and outcome. Its scope is so wide that it reaches not merely what is general and abstract, but not less that in which it is expressed imaginatively in the symbols of feeling and emotion.

THE PHILOSOPHICAL SIGNIFICANCE OF HUMANISM (continued)

CHAPTER III

FORMS OF HUMANISM

I ENDED the last chapter by touching on the distinguishing feature of Humanism in literature. It is a form of knowledge in its widest sense in which the stress is laid on that individuality and uniqueness which we find in what seems direct perception and in emotion. With this the distinctively humanistic purpose is concerned. The universals of knowledge are always latent. It is these that give their meaning for reflection to the works of art in which they are embodied. But it is not in the abstract form of general rules that they appear, for the end to which we are directing attention is different from the end of the man of science. It is in the main as values that we recognise them here, values which are foundational in artistic experience but are never merely abstract concepts. What is before us we recognise as imaginative constructions, born of the spirit. Mere reproductions of nature they cannot be. They require mind for their recognition and development. Personality is always implied in them. Here again we find the relativity of reality to knowledge. The highest may be the highest only in a particular period and its quality may alter. But the highest of its kind it is always seen or felt to be if it is accepted without reservation. If it is not so

accepted that is because we are aware of its deficiency in value, a deficiency which imports that the range of mind extends beyond it. There is no standard of universal applicability under all variations of circumstance, such as the mathematician discovers by abstraction in his invariants. But there is apparent value in the form which knowledge presents, a value which is there only for mind at a high level and which remains identical in knowledge despite differences in the mode in which reality presents itself in respect of periods and fashions of expression. That is the meaning of the doctrine of relativity as applicable to Humanism.

Knowledge is an entirety, and within that entirety appear many standpoints irreducible to each other which give rise to relativity in orders of appearance. The result is that reality discloses itself as varying in character. Now the reality with which Humanism concerns itself is one in which the form of knowledge is directed neither to general rules nor to abstract concepts, as what express its standpoints and standards of excellence, but to a mode of apprehension that presents itself as if more direct. We have seen that it is no passive apprehension, for mind is active there as elsewhere in the construction of the object in which it finds itself and only itself. Aristotle taught us this long ago. But the recognition of value and of standard or quality in value is the evidence that here, as in every other case, we cannot escape from knowledge, and that just because it is only through distinctions made by and within knowledge that we and our objects arise. Reality and unreality, truth and error, sin and righteousness, beauty and hideousness, all find their actuality and

the distinctions that are the foundation of such actuality in knowledge itself. But in Humanism it is in the main only on knowledge in certain of its many aspects that we are dwelling. The quality of beauty may be what absorbs our attention. It discloses itself in what is unique but is still an example of value, and so implies what is in ultimate analysis of a general character as an active moment in its nature.

What is true of beauty in form as we meet with it is also true of our impressions of what is called personality. There is always some kind of uniqueness in the men whom the world distinguishes as leaders, something that appeals to the imagination. No man is great merely because he preaches a particular doctrine. Whether it be in his deeds or in his words or in his writing, what moves those who follow him is what is beyond his mere doctrine, that in him which fires the imagination and makes others feel that in him there is what cannot be adequately described or forecast. He is for them an individual marked out from the others around him by a quality that cannot be exhausted in any phrases. It suggests what is not capable of being included in any abstract description. The universal is there, but in union with a particularity that gives it dynamic force. Here also we have the concrete universal, and we feel that in his way, if we recognise him as leader, we shall not look on just the like of this man again. Thought and will are not really different in nature. Both are activity, both dynamic in their capacity to transform their object world. It is only in the form of the transformations they bring about that they differ. The great man stands for the trans-

forming man. If he be an administrator of genius he will compel those around him to do his will by the inspiring power he brings to bear on them. If he be of the first order in literature or science he will create a school of disciples, inspired by faith, by the sense of what is unseen, and not merely by notional agreement with what he lays down. To exercise such power and to bring its might to fruition may in some cases require time, while in others the result comes quickly. The variety of such personalities is infinite, as the history of action and thought shows. But the lesson we learn is always that leadership depends on personality in some form, on the quality that comes from the grasp of universals that are concrete. A great leader is no mere book to read. It is because the study of him is inexhaustible, and involves the appeal to the imaginative and pictorial, that he lays hold of the mind of the man in the street. The approach to what is purely particular in character is here as elsewhere elusive, for it is asymptotic and incapable of definition. He may be very human, very finite. He may often be wrong. But if his knowledge or his power of action is dynamic and can compel the imaginations of men, his shortcomings, very real perhaps to the few that are sufficiently equipped to estimate them, will not destroy his power over the multitude who are drawn after his banner. Here is yet another form of Humanism, resulting from the fashion in which we all of us have to think in images that, while inadequate to full knowledge, are yet essential in it. For the real is never merely abstract. It is always concrete even in its general principles. This is a plain and obvious truth. We fall in love with persons, not

with qualities. It is just you, here and now, that we turn to, not to any abstract construction out of general principles. The devotion of a dog or a horse to its master is hardly less of this order.

In religion Humanism exercises a similar influence. It has been said truly that a test of its truth and work in practice is the scope it allows to disciplined imagination. The 'practice of the presence of God' has been given as the expression for a mode of its exercise. Such practice is made easier for the majority if it takes place when they are assembled together, with common conditions and a sufficient ritual. This means that emotion requires channels in which to flow readily, channels which symbolise universals in reflection. A few, and among them the best, have the faculty of supplying such universals through their own unaided reflection. But for the bulk of mankind co-operation under leadership is required for the stimulation of the reflection in which religious emotion is clothed. Still, apart from such emotion the universals become barren and tend to degenerate into formalism. Religion depends on mastery by emotion, the sense of self-surrender to what is highest. This sense is developed by the methods of its general expression. To some one set of symbols appeals more than does another. The emotion to be called forth varies with individuals. There are those with whom it must take the form, if it is to be real, of the consciously experienced presence of the sublime. There are others with whom it may be of a more personal and transitory form, and for these help from the repeated production of external conditions can count for more. But for religious men of all temperaments the sense of self-surrender, of willingness to die in order to

live, is essential in some shape if the highest is to be attained. In all cases the work of imagination comes in. The moving occasion is always in some sort symbolic. It is through a symbol that imagination gets its strength and practicability, and enables men and women to turn away from the engrossing details of daily life to what they feel to be abiding through the fashion of the day. This, too, is what binds them together, and makes them aware of a brotherhood in humanity which calls even from the very depths for compassion and mutual helpfulness. The reality of the appeal relates religion to ethical conduct, and demands a high ethical level. If the response to this demand is wholly absent we naturally utter the word 'hypocrite.'

Here, again, we see the stress that is distinctive of Humanism, with its emphasis on concreteness and the necessity for the recognition of that inexhaustible moment of the particular which is the condition of imaginative construction. The churches, the ministers, the ritual, are but symbolic of what is wider and deeper, a form which knowledge in its highest and fullest sense assumes, a form in which the general and the particular are inseparable in its reality. For such knowledge an effort of what we call will is indispensable; it is itself the outcome of a form of knowledge. Mind, in the aspect of disciplined will and emotion, is at the foundation. No animal short of man possesses mind of such a kind as to be capable of religion, and this is one of the proofs of the necessary presence of the universal as a moment in the religious consciousness. Other such proofs are to be found in the possibility of a large number of human beings joining together in the effort to develop that

consciousness and to keep it in a systematic shape alive. What is called fanaticism is due to excessive stress having been laid in such combinations on merely abstract principles, divested of the Humanism which expresses the actual character of the relation of the individual to God as immanent in him.

As in religion, so it is in natural science. Here we come back to observation of actual facts as the basic test. But the observation must be disciplined observation, and no unrestrained means of stimulating fancy. As Helmholtz says, Goethe was a very great observer, one of the most gifted on record. But even his acute experiments with the phenomena of light led him wrong. His mind was deflected from the significance of the discoveries of Newton in this domain because he was not adequately trained in mathematical principles. Had it been so he might well have attached to the facts he observed the same significance as they had for Newton. The history and subsequent development of knowledge about light has proved that Goethe got into a wrong path through lack of this sort of training. From want of knowledge of a general character he misconstrued what was particular.

To-day there are physicists of great eminence who are sceptics about the truth of the claim made by Einstein to have resolved matter into energy, energy into mere change of position, and change of position into relationships that are merely relative, with the result that space and time themselves are reduced by him to mere relations of relativity to the observer and his situation and conditions. Against this it is said that, although force is naturally interpreted through our subjective feelings

and muscular sense, it yet means something real, and that the relativity doctrine does not account for enough of what the facts reveal to be able to claim anything like the whole field. A residuary domain called that of the æther is, it is maintained, still required in order to account for facts observed. To this criticism Einstein replies that, so far, no such fact has been described which does not allow itself to be recorded and interpreted in the terms of his system. As to space and time and the æther, he insists not only that the old view of them cannot explain things that are beyond question in our experience, but that the significance which we attribute to them is due to our having taken them to be of a single form. A more adequate geometry, he says, the geometry which has been developed out of the work of Gauss and Riemann by bringing in, in addition, his own interpretation of the gravitational field, with the changing shapes and measurements of the relations in it, shows that space and time are of a more general character and vary far more as forms of experience than the old classical physicists have permitted themselves to think. The basic character that underlies both space and time can for him be expressed merely in definitions of a tensor character.

Only progress in work by the few whose minds are adequately trained for research in this region can settle which of these two schools of thought is right. It must be remembered that Humanism is itself capable of excesses as great as those of the abstract mind, and that under the stress of emotion we are always prone to humanistic excess. It is a temptation arising out of our natural preference for

what appears to be direct knowledge. But that which is taken to be direct experience constantly discloses itself as having been deflected by unconscious assumptions. The history of science, and indeed of philosophy generally, is the history of a slow but steady vindication by the universal of its claim to be equally real with the particular, and we therefore can never be certain how much of that which we have taken ourselves to have had directly revealed to us in passive awareness has really been the outcome of the activity of thought in qualifying particularism. Here we have the same character in knowledge disclosed to us as in art and in religion, only in more elusive form. The concrete is always a concrete universal. We cannot lay exclusive stress on either of the moments implicit in it or on the polar aspects which it presents. If we do, we fall in one case into the sin of the abstract mind, and in the other case into the disorderliness of those who build on shifting sand. The well-balanced intelligence takes full account of both aspects, refusing to be plunged into abstractions, on the one hand, or to live from hand to mouth, on the other. The mind of genius reaches a yet higher level, for it does justice to the claims of both by bringing them into larger wholes in which the two aspects are transcended and so reconciled in a fuller entirety. This is the secret of genius alike in poetry and in science. It is such genius that we see also in the highest triumphs of religion and in the most penetrating insight in science and philosophy.

The doctrine that every department of knowledge belongs to a single entirety, and can be adequately interpreted only in its organic relation to the other

departments, is of the very essence of Humanism. Between the pure mathematician and the poet and the preacher there are no gulfs fixed. Each deals within his own order of reflection and in its peculiar terms with the same material, the unique reality which belongs to a whole that discloses itself from differing standpoints. The reality, although varying in form, is the same, and it is possible to exhibit all forms of knowledge about it as organic to each other, if our outlook is wide enough. It is interesting to observe how this view is beginning to make itself apparent even in the present period in our own country, and perhaps more on the Continent than among the Anglo-Saxon peoples. It is a view which is essentially humanistic. We find it foreshadowed in the sayings in the *Upanishads*. There the problems of metaphysics are not discussed in what we of the West would call a sufficiently systematic fashion. But they are discussed nevertheless, and close attention is bestowed on the question of the nature of the self in knowledge. The spirit is that of Humanism, but the underlying principle is the doctrine that knowledge is an entirety, and that it possesses grades or levels. This is well brought out in the books and articles which have recently appeared from the pen of Professor Radhakrishnan, formerly of the University of Mysore and now, I think, of that of Calcutta, who is versed in the metaphysical systems of the West as well as in those of his own East. One phase of value in the study of oriental philosophy seems to me to lie in this, that the gap between thinking in abstract conceptions and thinking in images is reduced to what leaves the concrete nature of the humanistic outlook on life with its proper and full value.

But it is not only in India that we have the spectacle presented of an intense desire to grasp and realise the inherent unity of knowledge. A movement is on foot in the German universities which has so far attracted here less attention than it should. One of the best accounts of this movement, still in its infancy but being pursued with scientific thoroughness, is contained in a pamphlet entitled, *Humanismus, Hochschule, und Student.*[1] There was a conference attended by representatives of various German Universities, including representatives of the students as well as the professors, which took place at Hanstein, not far from Göttingen, in May 1921. The papers read and the addresses delivered are in substance reproduced in this pamphlet.

The purpose of the movement is nominally the establishment of a Humanistic Faculty. But in this connection 'faculty' does not mean a separate faculty of humanistic studies. With the existing distribution of subjects in the universities of Germany it is not sought to interfere. The real object is to bring these subjects into organic relation to one another, and exhibit university teaching not as a collection of fragments isolated from one another, but as the outcome of standpoints all of which have their places within the entirety of knowledge. Thus classics and pure science are to become no longer ignorant of each other, or of what each really signifies. This is to be accomplished by systematic work, in which the professors and students are to co-operate. The professors are to lead the students to the wider view of what a university can teach. Philosophy is to be made aware of science and science of philosophy,

[1] Published by 'Die Studentenschaft,' Göttingen.

and the atmosphere of literature is to be made available for both. This is to be done by lectures and courses of more general scope than that to which the universities have hitherto been limited. It is hoped that the movement will penetrate through university-trained teachers, with their outlook thus enlarged, to the new 'People's High Schools' which form a fresh feature appearing in German educational life since the war. These schools are being established in various industrial and agricultural centres, and their object is to continue the education of the democracy, after the age of eighteen has been attained, throughout the course of life.

With us in these Islands the plan for bringing the higher knowledge within the reach of democracy has been that the universities should take on new extra-mural functions, and that their fellows and tutors, increased in number for the purpose, should proceed to the industrial centres, and there reproduce as far as possible the system of university teaching in evening courses. In Germany the traditional spirit of the universities and their geographical distribution have made this more difficult. While the aim of the new popular high school movement is to produce what we aim at producing, a democracy with its mind trained partially at least in the atmosphere of a university, the main reliance seems to be on the work of the highly trained teachers in the great secondary schools of Germany, who are to do, outside their walls, what the university tutors we possess have assigned to them. It is too soon to be sure of prospects under either system, but in both countries the aim is the same. It is believed by the supporters of the movement in both

forms that the great problem to be solved is to lay foundations on which, not immediately but in the future, a democracy with a more enlightened mind than that of to-day can be produced, a democracy characterised by the stability in purpose and sentiment which only adequate mental training can found. Those who are at the back of this movement in Germany are, in the main, the same as those who are at the back of the humanistic movement to which I have just referred, and it remains to be seen how they will progress. Throughout its financial difficulties Germany seems to have no disposition to economise in education. The indications suggest that in this she is wise.

It is also a part of the policy of the German Government to insist on the policy of *Einheit* in the national schools. Before the war the children of the rich were generally educated separately, as has been the case here. This is being rigorously discouraged. Rich and poor are to have the same chances as far as possible, the only difference being that it is necessarily easier for the children of the rich to continue longer in educational higher courses than is practicable in the case of those who have to earn a living at an early stage in life.

It was Goethe who proclaimed what was, for a mind of his type, the peculiar value of the Scottish philosophy, as we find it in men so different as David Hume, Thomas Reid, and Dugald Stewart. "The reason," he says, "why foreigners—Britons, Americans, Frenchmen and Italians—can gain no profit from our new [German] philosophy, is simply that it does not directly lay hold on life. They can see no practical advantages to be derived from it, and so

it is that men turn more or less to the teaching of the Scottish school as it is expounded by Reid and Stewart. This teaching is intelligible to the ordinary understanding, and this it is that wins its favour. It seeks to reconcile sensationalism and what is spiritual, to effect the union of the real and the ideal, and thus to create a more satisfactory foundation for human thought and action. The fact that it undertakes this work, and promises to accomplish it, obtains for it disciples and votaries."

Goethe was in his own way a King of Humanists. We must not take his words as literal truth. Less than did Schiller he had appreciated what Kant accomplished—Kant, who was finally to overthrow the Scottish school of thought. It was not, as Professor Seeley reminded people, in an article which he wrote in *The Contemporary Review* in 1884, from any pedantry that Goethe turned his back on German literature. There were no German Miltons and Shakespeares against whose examples it would have been impiety to rebel. But could he not have gone back to the Minnesingers? He answered this question himself: "The Minnesingers lay too far from us; we should have had to begin by learning their language, and that was not in our way; we wanted to live, and not to learn." These, then, were the circumstances which drove Goethe to seek for foreign models. He could not find at home either poets or philosophers who could teach him how to speak in the great style. He was forced to look abroad. Shakespeare attracted him first; there he found, even in the heart of the cold north, the vigour, freshness, freedom, natural passion, and natural grace of which he was in search. But later on he thought he saw

that what was to be found in Shakespeare alone among the moderns was to be found everywhere among the ancients, and that the true home of the artist is not where an exceptional genius triumphs over the gloom of nature, but where nature itself is sunny and where men have a religion of joy. So it was with his study of philosophy. This he met with in his stride, and had to take account of it in a sustained effort to survey the whole field of knowledge. But never was he deserted by the conviction that reality assumed in all cases the form of the concrete universal. That was why the *Critique of Pure Reason* was not sufficient for him. But, as Helmholtz said in the criticism to which I have already made reference, it would have been better for Goethe, as a student of science, if he had borne in mind steadily that the real is not to be fully understood unless the principles which determine its form are disentangled in the light that can be cast by exact knowledge and by exact knowledge only. The general is implied in what is actual as much as is the particular. Apart from mind and the meanings in which it sets its objects, these two moments in our knowledge do not attain reality.

I will sum up what has been the purport of these three chapters in closing my endeavour. It seems, as the result of the inquiry, that the ultimate reality to which we come back in the end, and in terms of which alone we can express all the distinctions through which our universe is present to us, is just knowledge itself. It is our habit, natural and necessary for the purposes of ordinary life, but inadequate when we are seeking the foundations of mind and its objects, that leads us to assume that knowledge can be adequately explained as a property

of certain of these objects. In truth it is that within which subject and object alike fall as its own phases, and it cannot itself be described or interpreted in any terms that go beyond it. But just because of this, its foundational character, its objects are always what are disclosed in the unity which confronts us when we turn reflection on to the nature of our direct and actual experience. The real, from its very nature as belonging to knowledge, is, on the one hand, no construction by merely abstract thought, nor, on the other hand, has it meaning or existence apart from the setting which thought gives to the vanishing particulars with which it is concerned. The two phases have reality only in the wholes to which they belong and in which they are interpreted.

Such a view at least affords a principle through which Humanism can be vindicated and be made intelligible. It bids us to lay exclusive stress on neither of two abstractions, each of which taken in isolation is false, but to direct our attention to the fulness and richness of life, and to interpret these from a really comprehensive outlook.

PART II

THE PHILOSOPHICAL SIGNIFICANCE OF OTHER SUBJECTS

THE PHILOSOPHICAL SIGNIFICANCE OF OTHER SUBJECTS

CHAPTER IV

MATHEMATICAL PHYSICS

IN the observations I am about to make on the subject of Mathematical Physics I shall address myself in the main to those who, like myself, are concerned with the theory of knowledge. It is from this point of view, concerned as it is only with logical principles, that I write. In *The Reign of Relativity* an effort was made to work out such a principle and to apply it in various regions of science in which it seemed to appear. But the amount of ground which had to be covered compelled me to confine attention only to general features in the course of that survey. There are some matters which remain for consideration in connection with the physical interpretations, not always as it seems to me very clear, which the mathematicians offer of their symbols.

There are thus one or two subjects which I now wish to approach in rather more detail than in the earlier book. The first of these concerns a method adopted in the most modern developments of mathematical physics. For the light it is casting on fundamental questions philosophy appears to me to be under a real debt to those who wield this method. Indeed philosophy had got almost as far as it could in the only medium that was available, and its waters were tending to become stagnant.

To-day it has been furnished with other waters to navigate further. But that is neither all nor the most important thing. The conceptions and methods of the mathematical physicist himself are also being refashioned. Most of the physicists who are eminent as mathematicians have been at one about this, though a few still doubt. At all events, the majority have provided ideas so fresh that philosophy has before it a task such as it has not had for a long time. It can neither shirk the duty to attempt to find systematic expressions into which these fresh ideas may fit, nor can it itself advance without making an effort to interpret them for itself. Interpretation which may bring them into relation with other forms of knowledge they certainly require. Mathematicians are apt too easily to take their own formulas as adequately descriptive of the nature of reality.

I will begin by referring briefly to some points in the argument of the first part of the present volume.

In order to apply the principle of the form of individuality as basic to which these points were directed, let us ask what is the character of the object world of the physicist. The actual object in knowledge is, as we have seen, always and essentially individual and unique in character. Even when we think in the most general terms, as in tensor expressions or even in such as are yet more abstract inasmuch as they are of a purely logical nature, we really form images, with which we operate as symbolic of meanings of general application. When we point or feel it is also in every case with an interpretation through universals, which is essential to significance and so for reality. The logical moment of the purely particular is always present as

implied, but it is no entity apart from or independent of the universals in which it is set in knowledge. The purely particular is implicit in experience, but its nature is to be the asymptotic limit to the operation of reflection. We cannot even name such a particular as being merely such. If we try to do this we have transformed its character into that of an *individual*, for the description always implies general terms which are requisite for description of any aspect and which import what is of a universal not less than what is of a particular nature. Such a method as that of Extensive Abstraction, introduced as one of mathematical logic by Professor Whitehead, is akin to the method of the differential calculus. It attains to simplicity in the object it sets up by reducing it to the symbol for a limiting concept which has significance of a general kind only in and through a relation, and not as an independent entity which can confront knowledge as a self-subsistent particular.

This result becomes more and more apparent the further science is pushed. It brings the ultimate conceptions of science under aspects in which in the end they enter the domain of philosophy, and require the aid of the logician for their final interpretation. Knowledge is an entirety within which all its logical moments fall, but they fall into this entirety only as distinctions within the whole, and they have no meaning excepting as distinctions so made by knowledge.

None the less such distinctions belong, just on that account, to the foundations of our actual experience. In that experience they are bound to appear in some form. What seems at first sight particular always turns out to be what it is

because of generality in its meaning. It may be that certain of the problems which are to-day perplexing mathematicians and physicists will have a further significance when this, the essential characteristic of experience, is realised; possibly the difficulties of the *quantum* doctrine, for example. It appears that experience, when closely tested by analysis and experiment, shows the ultimate form in which action takes place, for instance in the radiation of light and electrical energy, to be one of discrete *quanta* of action. The form of action always has characters which point us to continuity, but these also imply discreteness, and the discreteness of form seems not less to confront the observer. What is the explanation of this? As a pure question of physics the reason of the phenomenon is perplexing. But if the double relation is the outcome of the very nature of experience, arising from the necessary union in the actual of general and particular in the uniqueness and individuality which characterise all objects, the form of the antithesis is one which may at least be expected.

We find the emergence of something like this form of antithesis in the *quantum* doctrine however abstractly we consider the object world. Geometry itself affords an example of this, and I shall presently turn to it. But before entering on this subject we must make clear to ourselves how much there is for the observer of which his geometry does not take account. About the extent of this there is controversy. The tendency, however, appears to be to insist that the actual object world which presents itself to us is of a highly concrete and individual nature, incapable of being broken up into what are

separately subsistent secondary as distinguished from primary qualities.

In the fourth edition of his book on the Conservation of Energy (so far available only in German), at page 169, Professor Max Planck, one of the pioneers of the *quantum* theory, and also a sharp critic of the attempt to exhibit the universe adequately merely in terms of the geometry of Relativity, or indeed of any other geometry, makes some characteristic observations about what he holds to be the true point of departure for the physicist. A humanistic tendency is apparent throughout. He points out that Newton and Kelvin, with whom he is on this point in much agreement, referred the notion of energy to an origin in that of force, actually experienced in the sense of pressure. The muscular sense and the senses of touch and feeling are those where it is expressed. The other way, he says, was, as with Kirchhoff, to define force and acceleration as identical, by doing which the notion of force lost in significance, inasmuch as all reference to sense was excluded. The advantage of the second idea was that the notions of work and energy became deductions from that of force. A third course was that of Huygens, who, Planck says, placed the concept of energy at the head of mechanics and assigned to the other ground-notions, including force, a secondary place. The advantage of this was that the characteristic concept of energy became a definable magnitude for *all* the different branches of physics, so that not only mechanics, but also the theories of heat, electricity, etc., could be grounded on this concept, and a more unified and far-reaching idea of physical phenomena could be obtained. For

this Planck holds that there is much to be said, provided that we accustom ourselves to the view that there is more in this concept of energy than is usually thought. For it has to be remembered that the notion of force, on which, since Newton's time, mechanics has been built up, has an advantage which that of energy lacks, in the fact that in the muscular sense we possess a sense through which indeed we cannot measure exactly but which gives us a direct experience that is lacking in the case of energy as such. He says that in Newton's view the idea of force appears as what is primary, as the cause, while motion and work done appear as effects, notwithstanding that force and acceleration are connected in time. The reason is, that when we alter the position of a body by muscular effort the physiological phenomenon in fact precedes in time the motion to which it gives rise. Even when a body which is independent of our muscular activity is set in motion by the attraction of another body, we can always imagine this as taking place through some kind of pull, and so we speak with a definite meaning of a force as producing the motion. That the measurement of the force takes place only through observation of the motion which follows does not affect this conclusion, nor does the fact stand in the way of our recognising, with Kirchhoff, that if we proceed to abstract from the relation of the concept of force to that which muscular feeling yields, we can treat force from a purely kinematical standpoint, as for instance in astronomy and all the sciences which depend only on perception through sight. Still, physics, says Planck, is concerned with the description of every kind of form of external

phenomena, temperature, colour, etc., and accordingly in the end we come back to reference of fundamental physical ideas to the sensations of the various specific senses. These may reveal to us new material which we have to be in a better position to incorporate than we can be if we take a view which, though of great practical use, is not necessarily adequate to the possible fulness of experience.

Planck's criticism of attempts to resolve the individuality of experience into certain universals is at least an indication that there is always in science a residuary phase, a particularity in what is objective which cannot be so resolved. If the advocates of the necessity of recognising the existence of an æther would confine themselves to this, instead of insisting that their æther must have the status of an independent and individual entity, some reconciliation of conflicting standpoints would be possible. Here, as in some other cases, physics has at times laid itself open to the criticism of the logician.

The same thing seems to be true of the classical conception of empty space as significant in itself apart from the observer. Newton was driven to so conceive it as the foundation for his principle of inertia. In his time such a conception appeared, as it does not so appear to-day, to harmonise with all the results of exact observation. Those who wish to see how for Newton the conception of our space as absolute and uniform was inevitable will find the subject worked out in Professor Max Born's recent book, *Die Relativitätstheorie Einsteins*. Deductive methods have played an even larger part in our conceptions in physics than we realise. And

nowhere is this more apparent than in the story of the development of geometry itself. It has been profoundly influenced by the ideas of objectivity to which it has been applied. Our ideas about space appear to have been come at too easily.

The geometry of Euclid rested on an assumption which appeared very natural. It postulated that in a plane surface on which there were a straight line and also a point outside that line, there was only one other straight line which could be drawn through the point so as not, when prolonged, to cut the first line. This was the axiom of parallels, which implied a fundamental assumption about the freedom from inherent curvature of space. Many attempts were made to prove its truth, even in the days of the Greeks themselves; but these attempts, even in their time, gave rise to doubt. Mere observation could not exclude the possibility that there might be drawn through the point a pair of straight lines asymptotic with the original straight line and dividing the lines through that point into two bundles, one bundle of lines cutting the given line, and another bundle of lines not cutting it. Alternatively there is Riemann's hypothesis of finite geometry, in which every line returns into itself. In this geometry any two lines in a plane successively intersect. Neither of these hypotheses have any necessary reference to any heterogeneity of space. But Riemann's method allows such an hypothesis to be entertained. It is on this possibility of spatial heterogeneity that Einstein's discoveries are based. Space might have in its own character a curvature such as to involve this.

In our own period the doubt has been worked

into systematic form. Early in the nineteenth century Lobatschefsky, who was Professor of Mathematics at the University of Kasan in Russia, and Bolyai, an officer in the Austro-Hungarian Army, produced systems of geometry which did not assume the validity of the axiom of parallels. The question of the general character of space then began to be realised as being an open one, and questions were soon put in searching fashion.

For our forefathers space and time were fixed and independent forms or frameworks in which things existed. Even Kant really thought of them in this way. For others, if not in the main for him, matter was a substance set in such frameworks. Each particle of matter had its place at a definite point of space and in a definite instant of time. We thus got to a world of supposed invariant primary qualities, and these fitted in admirably with geometry as Euclid conceived it. But criticism of the conceptions presupposed in this presently set in. That criticism in its later stages came largely from two ultimate sources. One was the work in physics of Faraday and Clerk-Maxwell, who directed attention to the 'Field' in which action takes place as requiring to be itself interpreted before any clear light could be got on the character and behaviour of the matter which had to be interpreted with reference to it. Still later on Minkowski and Einstein came to think that this field could not be adequately interpreted unless it were first understood that time and space mutually implied each other, and were indissoluble aspects of reality—aspects which only the abstractions of mathematics could treat, even for limited purposes, as independent.

The stimulus given by the new conception of the importance of the field led to a revision of mathematical ideas. In the investigation of such a field we require differential expressions which enable us to make abstraction from what is irrelevant by confining ourselves to what is indefinitely small—in other words, to limiting conceptions as our guides in calculation, instead of to what are imagined as possible individual objects in sense perception, however minute. This method was extended to the investigation of space taken by itself. Before this was done effectively the notion of space had to be reconsidered.

Riemann was not satisfied with the conception of space current at his time. He endeavoured to resolve the individuality of the phenomena of the external world. For Riemann the universals into which this individuality of spatial phenomena must be resolved if it is to be made scientifically intelligible, have to be of a wider and more fundamental nature than those characters beyond which Euclidean geometry does not go. It is an epistemological question not less than one which is mathematical, and he says so in his essay on the hypotheses which lie at the basis of geometry. Geometry assumes, he says, as things given, both space and the first principles of construction in it. But "she gives definitions of them which are merely nominal, while the true determinations appear in the form of axioms. The relation of these assumptions remains consequently in darkness; we neither perceive whether and how far their connection is necessary, nor, *a priori*, whether it is possible." As neither the mathematicians nor the philosophers had cleared up the darkness, Riemann set himself to do so. His self-imposed task was that of "constructing

the notion of a multiply extended magnitude out of general notions of magnitude. It will follow from this that a multiply extended magnitude is capable of different measure-relations, and consequently that space is only a particular case of a triply extended magnitude. But hence flows as a necessary consequence that the propositions of geometry cannot be derived from general notions of magnitude, but that the properties which distinguish space from other conceivable triply extended magnitudes are only to be deduced from experience. Thus arises the problem, to discover the simplest matters of fact from which the measure-relations of space may be determined; a problem which from the nature of the case is not completely determinate, since there may be several systems of matters of fact which suffice to determine the measure-relations of space—the most important system for our present purpose being that which Euclid has laid down as a foundation. These matters of fact are—like all matters of fact—not necessary, but only of empirical certainty; they are hypotheses."

Riemann, like Clifford in the passages referred to in the Introduction to the present volume, thus sets himself to the analysis of the principles and universals which have to be disentangled for the comprehension of the concrete individuality of our spatial experience. He divests himself of humanistic tendencies, and his investigation becomes a highly abstract one. For his result is that space proper, taken in itself, is no more than a three-dimensional manifold devoid of form (not an easy conception to understand, inasmuch as three dimensions and manifoldness seem to imply *some* form), and that space possesses definite shape or form only in virtue of material contents which not

only fill it but determine its metric relations. If matter is displaced in space it will therefore carry its own metrical field along with it. The material content transferred from one position to another may thus be continuously deformed in the process, and yet in ultimate analysis remain congruent with itself, inasmuch as it carries with it the metrical field which it produces. In a manifold of a continuous character the metric relations encountered must have their explanation sought, not in any character of space itself, but in that which fills it in a fashion which is determined by 'binding forces' acting independently. Einstein's 'gravitational field,' in his general theory of Relativity, has since been said to be an illustration of such a binding force.

Riemann aims at bringing us in this fashion to a true conception of the nature of space when freed from the shapes and measurements which are imparted to the objects in it by the empirical and arbitrary apprehension of individual phenomena. Space becomes under his analysis a highly abstract conception of a purely general character. It is an n-dimensional continuum. But it becomes continuous only in virtue of success in eliminating variety in its contents by the employment of methods confined to the infinitely small. Geometry is now a differential geometry. Only by means of infinitesimal treatment can we eliminate contingent variations in experience. 'Affine' geometry which takes cognisance of finite distances, as in the case of Euclid, ignores the necessity of grappling with the difficulty. Riemann will not have it so. He excludes from the domain and scope of his infinitesimal geometry the finite distances with which the affine method concerned itself. Since

his day Weyl has criticised even Riemann, as will be seen later on, for having assumed that it is possible to compare the lengths of two line elements at finite distances from each other, and has insisted that it is not permissible to use comparisons at a distance in the geometry of the infinitely near. This may be right. The conception of the infinitely near appears as essential if we are to eliminate discontinuity in the manifold taken in itself. It seems that, as Riemann suggests, this can be accomplished only if we confine ourselves for the basis on which we are to build to linear displacements relative to a point, and remember that there is no place in such a purified conception for thinking of the infinitesimal displacements of any separate points as equal or unequal. Following Gauss, Riemann came in sight of a much more general view of such displacements in which they appear as no more than what are called 'components.' These vary, but not in the form of changes such as we find in empirical space. It is within the analytical field in which for mathematicians a point is determined that these components are alone definable, and that an adequate description, independent of shape and measurement, can be given of their relations to the point as one in pure space. That is how we come to invariance. It is a quality only of space in its most abstract and conceptual aspect. The relations dealt with as invariant in the tensor method which is alone appropriate to them belong, according to such mathematicians as Weyl, to a point and not to space treated as an empirical whole. The tensor is a linear form which may contain several series of variable components, dependent on the co-ordinate system adopted, for the immediate neighbourhood of a point.

Confining himself to infinitely small quantity the mathematician is able to make his basic conception a linear one, and his infinitesimals line elements at the point in question. This enables him not only to treat space as continuous for final metrical purposes, but even to regard the Pythagorean principle as to the squares of these line elements as strictly true. He can do so if, but only if, he confines himself to infinitesimal relations as his foundation.

But the doubts I have referred to in connection with what was called 'affine' geometry led to further doubts about Euclid. If the axiom of parallels which Lobatschefsky and Bolyai had brought into disrepute was not well founded, could we safely assume that space was homogeneous? Might it not present different characters as we proceeded, such that by its very nature it gave altered forms to its contents, instead of leaving them self-subsistent and characterised by Euclidean straightness in dimensions? It seemed as though at least in the domain of the infinitely great such a question might be of much practical importance. Need the dimensions of space consist only of three? It is true that our ordinary picture of space is as of three dimensions, and we cannot draw on paper any adequate picture of it as having more than three. We exhibit the position of a point in it by using three dimensions and no more, and the co-ordinated lines are sufficient to describe the position of any point which is at rest. If we want to exhibit a point in motion we can only use the three-dimensional picture if we add to it what is merely symbolic, a co-ordinate standing for the change in time which is implied by motion. But this shows that, for our description of

physical reality, the three dimensions of space are not enough. If we wish to describe nature we know well that we often have to describe in terms of more than three standards of reference. It does not matter whether we call them co-ordinates or vectors; the point is that an indefinite number of such standards may be required for our account of phenomena. If we wish to describe scientifically the behaviour of the molecules of an assemblage of mixed gases we must know the vector action of the molecules of each gas. The relevance of this is to show that, wherever we are dealing with what is in its nature manifold, we may have to employ in description an indefinite number of magnitudes, which we can call co-ordinates or vectors or what we please, representing the continuous elementary functions within that manifold. Now, Euclidean space may turn out to be no final form, but only one got by leaving out of account other dimensions which we cannot picture but which are required to make intelligible the actual behaviour of the objects in our world. We must not assume that the space which gives its form to the surface of the earth itself is uniform in the fashion conceived by Euclid. Gauss doubted it, and his doubts were carried so far that Riemann, one of his successors at Göttingen, found himself driven to a new conception of geometry in which space might theoretically have an indefinite number of dimensions, such that, although we could not make a picture of them on a paper surface, they could explain certain limitations which Euclid's geometry had seemed to impose on our interpretation of our actual observation of the behaviour of things. It is Riemann's idea which Einstein has developed further in his explanation of

the apparent contradiction of current physical reasoning by the observed deflection of starlight and the perihelion of the planet Mercury. It is therefore worth while to ask what Riemann meant when he declared himself compelled to search for a foundation of geometry which should be wider than that conceived by Euclid.

"The transition," says a prominent contemporary mathematician,[1] "from the geometry of Euclid to that of Riemann turns on an idea analogous to that in physics of action at infinitely close quarters. For example, take Ohm's law. We determine by observation that the stream flowing through a conducting wire is proportional to the differences in potential at the beginning and the end of the conduction. But we are satisfied that in this result of measurement of the current in a long wire we have not got before us a law of nature exactly manifested throughout, but that such a law can be inferred from the measurement when referred to an infinitely small section of the conductor. It is really so that we come to the formula that underlies Maxwell's theory. From the differential law we proceed backwards in mathematical fashion to the integral law embodied in what we observe, if we presuppose relations that are throughout homogeneous. Just so with Riemann's geometry. The basic fact for Euclid is that the square of the distance of two points is a quadratic form of the relative co-ordinates of the two points. If we look on this law as strictly valid only if the two points are infinitely near each other, we come to Riemann's geometry, and are at the same time lifted above the necessity of a more exact

[1] Weyl, *Raum, Zeit, Materie*, 4th Ed., p. 81. Cf. English Tr., p. 91.

determination of what is meant by the co-ordinates, since the Pythagorean principle just referred to is invariant whatever may be the transformations. The transition from Euclidean 'distant' geometry to Riemannian 'near' geometry corresponds to that from the physics of action at a distance to the physics of action at infinitely close range. The geometry of Riemann is that of Euclid so formulated as to conform to the spirit of continuity, and by being so formulated it assumes a much more general character. Euclidean geometry is constructed for the investigation of the straight line and the plane; these are the problems to which it is directed; as soon as we pass to infinitesimal geometry it is most natural and rational to build on the infinitesimal principle of Riemann. In this fashion we escape from complication, and are preserved from entanglements with a geometry of finite distances which may not be in accordance with facts. In the space of Riemann, analogously, a surface is indicated as a two-dimensional manifold by means of a parameter representation $x_\iota = x_\iota\ (u_1\ u_2)$. If we apply the resulting differentials, the fundamental metrical form of Riemann's space, we get $dx_\iota = \frac{\delta x_\iota}{\delta u_1} du_1 + \frac{\delta x_\iota}{\delta u_2} du_2$. We thus obtain for the square of the interval of two infinitely close points on a surface a quadratic differential form of du_1, du_2 (as in Euclidean space), and the metric of the three-dimensional space of Riemann transfers itself immediately to every surface lying in it and converts it into a two-dimensional Riemannian space. Thus, while with Euclid space is taken to be of a much more specialised nature

than the possible surfaces in it—that is to say, as flat—with Riemann the conception of space has just the degree of generality that is necessary to remove the discrepancy. The principle of interpreting the world through its relations in the infinitely small is the governing motive both in the physics of action at close quarters and in the geometry of Riemann."

Riemann said that in a Euclidean space of four dimensions Euclidean geometry would apply to a three-dimensional linearly represented collection of points, but that curved three-dimensional spaces, which may exist just as readily in four-dimensional space as curved surfaces can in three-dimensional, were in a different case. Was it not possible that the three-dimensional space of our perception should be really a curved space? It does not appear, indeed, as if imbedded in four-dimensional space, yet it may be that its intrinsic measurement-relations are such as cannot consist with space being flat. It may be that a sufficiently close measurement of our space after the fashion of a minute geodetic survey of the surface of the earth, would show that its space was not flat. Gauss was indeed at one time so impressed with this doubt that in the year 1821 he measured the triangle formed by the tops of three hills not far from his observatory at Göttingen, the Inselberg, the Brocken, and the Hoher Hagen, with a view to bringing the question to the test by ascertaining whether the sum of the angles of the triangle diverged from that of two right angles. No such divergence was actually ascertained, but this he thought might be due to its falling within the limits of possible error in using the instruments. The test remains unmade in this fashion, though Einstein and others have

made it in other regions of observed space and have claimed that the doubts of Gauss and Riemann turn out to have been well founded.

Logically there seems to be no difficulty in the Riemann view. It is true that we imagine that space has only three dimensions. But this is a rash conclusion. Things in space are always, as we find when we inquire closely, in motion, and motion implies time. It may be inapt to employ the word 'dimension' as a name for the time relation, but this relation has to be very fully taken into account, especially if space and time are only abstract constructions from the fundamental manifold or continuum in which the world really exists. And as regards logic, we can treat space mathematically as having any number of dimensions we please, and reason about it on this footing. We have, in short, here as elsewhere, to be fully aware of conventional habits.

There are some things which the mathematicians tell us that we may indeed hold to. We may keep to the view of space as being for many purposes a three-dimensional manifold. We may keep, at the other extreme, to the view that its infinitesimally small line elements can be compared with one another in independence of their position and direction, and that the square of the length of the interval between two neighbouring points may be described by the use of suitable co-ordinates in a quadratic differential form. Such an assumption is said by mathematicians to be founded on good sense, for, inasmuch as every transformation from one co-ordinate system to another carries with it a formula of *linear* transformation for the differentials of the

co-ordinates, a quadratic differential form must always pass into another such form. This reasoning, however, does not seem to give any ground for the assumption of the Pythagorean law of the quadratic form in preference to a biquadratic form, or to one of an even higher power. But perhaps the preference for the Pythagorean form is founded on experience.

Let us see what this signifies. It has brought us to regard as inadequate the familiar idea of Euclid's space as an independently existing framework in which matter is embedded. Space has no meaning apart from the world that exists in it, and that is straight or curved only inasmuch as space is itself straight or curved. Differences in curvature may exist everywhere. For Newton the curvature of space itself was *o*. For Lobatschefsky and Bolyai the curvature was different but still a constant. For Riemann it could be anything anywhere. Objects in it may thus be constantly undergoing deformation.

But for Riemann's methods there are still principles which do not vary and that are recognisable as permanent through all changes. At these he arrives by the use of his infinitesimal methods. The co-ordinates of a point indefinitely near to another point can be exhibited as functions of the latter point. He is able to establish a system in which the functions can be determined mathematically in independence of their actual measurement or shape; in other words, as logically antecedent to the results of the observation that is really based on and implies them. The relative co-ordinates, dx, etc., of the neighbouring point are the logical components of a lineal element in the point from which the departure is made, or in other words of an infinitesimal displacement from it

of the neighbouring point, which is dependent for its quality and character on that of the first point. The question is one, not of measurement or shape—we have not yet got to these although starting from experience in which they appear—but of mathematical analysis of what is implied in the definition we give to the position of the first point in what is primary in observed space. What we are concentrating on is not the distribution of matter itself, but the field of activity of the point-events at which we arrive by the method of limits when we use an infinitesimal basis for calculation. We want to find a way of expressing the field of activity of point-events that are indefinitely close to the point-event from which we depart.

Now this is what Riemann, by his new conception of the character of space, and Gauss, by some yet earlier work, have enabled mathematicians to do. Gauss discovered that curvature could be defined by differential analysis in terms of inherent metric relations alone of the surface. He devised for this purpose what are called Gaussian co-ordinates, lines of curvature on a surface which can be drawn across each other through every possible point on it, and which define the position of the point. They remain for differential analysis invariant in their properties through all deformations of the surface, provided it is not destroyed by being torn, and can be applied to the case of three-dimensional surfaces. Each point can in this way be made to correspond with some number in a completely 'dense' series of real numbers. This gives us what mathematicians (though not metaphysicians) mean by continuity.

Riemann extended this principle to quadratic

differential forms of three or more variables. Their relations were not numerical but of tensor form. Tensor relations are such when they characterise unambiguously and essentially a linear algebraic form of such a nature that by itself, apart from measurement, it describes the character of the magnitude to which it has reference. They are expressed as the right-hand side of an equation descriptive of the magnitude of an infinitesimal interval between two points, such that this side contains analytically ascertained components which remain invariant however much the measurement and shape in the infinitesimal interval may be conceived as altered through the system of empirical measurement of objects adopted. The tensor relation does not express explicitly or implicitly any ordinary quantitative measurement of the intrinsic character of the interval. But it is a function of that intrinsic character, and yields information which does not depend on measurement of shapes in a particular system of objects. It holds for all co-ordinates of points that can be derived by mathematical transformation of the co-ordinates in that system. It appears to be logically a residuary result obtained by eliminating description of what is individual in objects, and to be itself descriptive only in terms of the highest generality. It is thus that the new method has made possible exact knowledge of what lies beyond the limits to which alone the old notions were confined. The method, which in the hands of Gauss and Riemann was applied only to space, has, by Minkowski and Einstein, been extended to the investigation of the underlying manifold or continuum in which space and time have not yet been distinguished by the abstractions

we make in daily life. If this continuum was to be capable of description we should have expected a method for the ascertainment of certain definite qualities possessed independently of formed space and time to be supplied to us, and this the mathematicians have provided by recent tensor theories. The theories do not give us the definite measurements which physical science requires, but they guide us towards conceptions which are essential if we are to interpret these measurements, and to render them congruent as they occur in varying situations and under varying conditions.

THE PHILOSOPHICAL SIGNIFICANCE OF OTHER SUBJECTS

CHAPTER V

MATHEMATICAL PHYSICS (*continued*)

If we start from what is individual in the actual world and is therefore different from either space or time taken in abstraction and by themselves, the mere fact of change in events, we find that its consideration involves discrete as well as continuous aspects that imply each other, aspects such as position and motion. These aspects we hypostatise through reflection into what are for us the developed notions of space and time. Both are required as logical moments in that which we resolve through abstract distinctions. Position is a spatial 'now.' It does not remain at rest or static, because of the time-moment that is inherent in its character. It passes by its very nature into what is different position. What is 'now' at the limiting instant becomes 'then,' or, if it has not appeared, it is to be. The 'now' is the mere limit through which the past is distinguished from the future. Change, or what we mean when we speak of motion, is inherent in the object of reflection. We thus resolve into the point-instant. What it is in logic it is for us only as a limiting ideal in reality. Taken by itself space implies and passes over into time, and analogously time into space. For analysis the actual involves both as its logical moments.

It is of the essence of our procedure when we

observe to make this resolution. The double character of the outcome affects the result profoundly. The resolution which we make implicitly in what we call our experience is bound to be always relative to the observer. He splits up the continuum, of which he is primarily aware as unresolved, in ways which are always dependent on himself. Mere animals, deficient as they are in concepts, apparently do not measure space and time as we do. They are aware of objects as coincident or non-coincident, but their reasoning does not seem to go much beyond this or to enable them to measure in any form resembling miles or yards. They know when they are tired or hungry, and of the concurrence of certain conditions with the place of rest or feeding. It is important knowledge for their practical purposes. We ourselves depend for much on such awareness of coincidence. The co-incidence of the top of the thread of mercury with a mark on a thermometer is experienced as also coincident with a certain temperature. It is to the notional idea of coincidences between what we describe reflectively as intervals between point-events that we turn when we erect symbolically the structure even of our tensor theories, eliminating by abstraction all shape and measurement. That is how we put together our theory in order to get knowledge of relations between changing events which are always inherent in the ultimate foundation of what we observe, and are not merely relative to our individual circumstances in observing.

When in reflection we resolve the passage of bare events of which we are primarily aware only as in a state of change we can carry out the elimination of the irrelevant to its final result. This gives us, if

we proceed on the principle, analogous to that of infinitesimal analysis, which Professor Whitehead has called the method of Extensive Abstraction, a timeless or instantaneous space, and also a mere spaceless succession which we treat as pure time. Yet these are only limiting notions, valuable as ideals and as guides in method, but without correspondence to any concrete individuality directly disclosed by observation. Indeed in the reflection which aims at being most abstract and free from the moment of the particular it is simply as limiting notions that we get at them, notions expressed, like all other mathematical conceptions, by symbols or images.

Bergson's 'duration' is analogous to pure time. It is only, as he tells us, by spatialising it, as by representing it on the dial of a watch, that we can measure or even represent duration, and in so doing we transform its character. It is therefore the pure flow in duration that the metaphysician, the man who carries logical analysis further than the physicist does, refers to when he speaks of the duration with which Bergson is concerned. The physicist himself, the astronomer, for example, never gets to bare time. Einstein's doctrine of Relativity, with its introduction of the transformation in standpoint effected by change in motion and position in the gravitational field, shows that this is so. Whatever be the full truth about Einstein's doctrine, he seems at least to have established that the measurement of time in physics is relative to particular standards of situation automatically forced on the observer. Even the velocity of light is, for his general theory, in truth no absolute constant. The interpretation of its path must alter with the curvature of the space existing

in the particular gravitational field under observation. An astronomer on a remote star, with a distribution round him of heavenly bodies different in form from that of an observer on the earth, will estimate coincidences and simultaneities of the instants at which light-signals appear differently from the observer on the earth. The velocity of light must remain relatively constant, but it will have a different interpretation, in point of measurement and direction. Now that the æther is generally considered to have been deposed from the status of being an independent entity disclosed to us, and now that the absolute frameworks of time and space have gone with it, the astronomers have no absolute standard to measure by excepting the velocity of light itself. We are forced, as observers, to treat the velocity of light as a constant, because back to it we always have to come as basic in the rendering of our experience. We have to accept it as a final physical standard with reference to which we estimate, and for that reason we bring out our resolution of velocity in a form that does not vary. The time and space units, such as miles and seconds, preserve their proportions in the resolution of the velocity. That is why this does not appear to vary. But the units themselves alter in significance. They are not themselves constant, although the velocity is so which their proportions are used to define. The necessity of finding some congruence in nature drives us into taking the velocity of light as being the most suitable constant in observation. Possibly we might have chosen other physical constants, the velocity of sound, for instance, but immense complications and difficulties would have ensued. Yet what does this constancy

signify in the case of the velocity of light? Something that may have a wholly different interpretation for differing observers, even when they start from it as their ultimate standard. If the astronomer says that he is measuring time he is thinking of something which varies in character from what the logician means by measurement with an absolute standard, as much as when he is measuring the space which he observes in contrast to the instantaneous space of the latter. He is concerned, not with a limiting notion, nor even with the logical conditions which render congruence possible, nor, on the other hand, with anything of which he is immediately aware, but with the outcome of a set of inferences which he makes from supposed facts without being explicitly conscious of their true hypothetical basis.

The Morley-Michelson experiments awakened the world from its dogmatic slumber in this region of knowledge, and the Fitzgerald-Lorentz contraction hypothesis could not restore the tranquillity which had been broken. Einstein has brushed the perplexity aside with his principle. He says that it arises simply through ignoring that all physical measurement, whether of time or of space, is relative and not absolute, and is dependent on the situation and conditions of the observer; on whether he can properly be assumed to be at rest, or whether he is not just as much moving with accelerating velocity and in paths of a kind which may present no analogy to straight lines. If the world is in final result one in which time and space are not independent entities, but dimensions which we construct by the abstractions we make, as Minkowski held, the notion that there can

be any absolute external standard for the estimation of measurement or shape disappears. We are thrown back in any inquiry into the ultimate nature of congruence to regarding it as being what arises out of the foundational character of knowledge itself. The supposed constant velocity we observe in light becomes the outcome of assumptions that work sufficiently for daily practice, but only mislead when we come face to face with deeper and more remote problems, the solution of which physical science itself has to ignore. The propagation of a light-ray is the highest velocity our physical conditions have enabled us to observe. In this sense it has a special value, inasmuch as it links time with space ; the bare succession of instants at one point with the relation of order of points along a line. But a final constant it cannot be, however impracticable it may be for observation to get behind it. Reflection drives us to insist on a deeper lying standard, accessible at least to the power of abstract methods. There is no such thing as a time system the same throughout the universe. What we find is a set of diverging mathematical systems of location of events in types of linear succession, which are measured on a basic physical hypothesis according to varyingly applied rules.

If we could take mind, for the practical purposes of our daily lives in the observatory and elsewhere, as the subject which is inseparable and indistinguishable from the object which falls along with it into the single entirety of knowledge, we should find a way of deliverance from our troubles. Complete congruence would be intelligible. But we cannot take mind to be such a subject, at all events as we are conscious of it at our ordinary practical level, and

as belonging to our usual order in reflection. It expresses itself in our ordinary consciousness in organic form, as an individual human mind with a period and situation in a physical world. Such an expression may be itself only relative. But it is the 'this' which we have to make our point of departure and we cannot rid ourselves of it. We may resolve its interpretation into universals of thought. These, however, do not exhaust it, or free us from the moment of particularism. Mind as we find it is individual, and as such a particular fact in our object world. To cover completely such individual uniqueness a description would be necessary that was unambiguous, what the Germans call *eindeutig*. But through universals we can never render any such description, however much abstract knowledge the universals may convey. The knowledge they give is always reflective and of a general and indirect type which is inadequate to the exhaustion of the concrete immediacy with its moment of the particular. This does not mean that the particular is some entity by itself. If it were we could describe it in general language, and this is just what we cannot do. It is a notional limit to our intellectual series of progressively abstract conceptions, which itself lies outside that series. Human minds, conditioned as they are, can never exhaust what is unique and essentially concrete in individuality, though we may make progress endlessly towards its description in general language. We have seen how this is so with the 'here' and the 'now.' Mind at a reflective level higher than ours might conceivably escape the difficulty that is self-imposed. The distinction between general and particular is after all one which knowledge

has itself established, and which therefore falls within knowledge. If, then, knowledge had before it all such distinctions as having been made within itself, together with its own procedure in making them, it would be of a nature higher than our human knowledge in that it was free from the relativity which the limitation in our standpoints imposes on comprehension. For us, in whom mind expresses itself by giving to its quality as intelligence to an organism in which the senses and the intellect have their definite characters and are what they are in so far as they realise purposes, knowledge must remain conditioned, the limitlessness of its abstract range notwithstanding. Something of this kind appears to have been in the mind of Max Planck when he wrote what was quoted at the beginning of the last chapter. As it expresses itself in us knowledge does so in the medium of sense as well as thought. That is because of the conditions under which it realises itself in space and time and life in them. It is these conditions that determine its finite character. But it is none the less on that account knowledge, the inherent power of which is to resolve indefinitely into universals the actuality which comes before it. The particular moment in this it can never exhaust. That is because its aspect as intelligence is only one of the aspects of such knowledge. In another aspect it depends for its material on sensation, and so depends because of the nature of the object-self in which it manifests itself as knowledge. But it discloses for us the inherent significance which is inseparable from reality and gives it its meaning. In bringing out in that reality its conceptual aspect it provides the means for ex-

tending knowledge inferentially. A distinguished contemporary mathematical-physicist makes an observation about the differential equations in which Clerk-Maxwell has expressed the character of the electro-magnetic field which illustrates this quality in the procedure of knowledge:

"Their beauty of form is by no means unessential. It unveils the simplicity of the processes of nature, which remain concealed for direct apprehension because of the limitations of our senses, and only discloses itself to the understanding that can analyse."[1]

We are now in a position to see what Einstein has really accomplished. He has done for the world of externality generally what Clerk-Maxwell did for the electro-magnetic field. He has investigated the relations between objects in the external world by means of a searching analysis in which his conceptions are wider than those of the older physicists, and the analysis is consequently less limited by conventional assumption. The method has the characteristic quality of all scientific method. It first assembles the facts as experience, purified as far as practicable from tacit assumption, and presents them in the relatively direct awareness which is the starting-point in such experience. It then resolves them into universals, which now attain a more general form because of the extent to which the analysis has been carried.

What is called his 'special theory of relativity,' that which he had reached by 1905, had brought Einstein to this point. He had shown how to so formulate the laws of physics that they should assume an expression in which they would be true and

[1] Born, *Die Relativitäts-theorie Einsteins*, 2nd Ed., p. 134.

comparable with each other for all kinds of system appearing to an observer, provided that these systems were moving relatively with uniform velocity and rectilinearly. Given these conditions all measurements of space and time relations made by an observer in one system could be translated into the measurements made by another observer in a different system. The measurements would have different meanings and would be different if compared by a common standard. But they would be capable of being rendered congruent, provided it was remembered that their differences resulted from the differences in the situations and conditions of the respective observers. In this way Einstein got results analogous to those reached by Lorentz. But he got at them much more naturally if his theory of the relativity to each observer of the measurements of his space and time was right. Lorentz had to assume a contraction of the observer and his instruments due to the effect of a supposed variation in the resistance of the æther. Einstein had superseded the hypothesis alike of absolute Newtonian space and time and of a substantial æther itself. An æther absolutely at rest was only established if motion relative to it could be detected by observation. The experiments of Morley and Michelson had shown that no such motion could be detected. The contraction hypothesis, which had been artificially resorted to in order to explain this negative result, was now superseded by an explanation of a mathematical kind, in reality simpler and less obscure, in which the æther became a general appellation, not for some independent entity analogous to Newtonian space, but for some sort of collective basis underlying phenomena.

It became apparent to Einstein that his theory must be carried further if it was to furnish a full explanation. The world before us does not consist of inertial systems in uniform and rectilinear motion relatively to each other. It displays changes in the positions of bodies which alter in rate of motion, in virtue of accelerating velocities and paths that are not rectilinear but curved in every kind of fashion. The planets do not move along the straight lines which for Newton were natural and only altered by gravitation. Are inertia and gravitation, then, two different forces? Or is it possible to resolve them into manifestations of a more general form of change that explains them equally? The experiments made by Eötvös with the torsion balance had seemed to show that inertial and gravitational force were *de facto* equivalent. How were these so-called forces, with their apparent equivalence, to be explained? This is the problem which Einstein claims to have solved by his later and general theory of relativity, which develops the special theory until it appears as merely a special case of a principle of far wider ambit. Its original framework was too narrow to include all the facts with which he was confronted. In the developed theory this framework is widely extended. It gives us a set of further principles into the terms of which we can translate nearly all, if not all, of the laws of physical science so far as they are at present known to us.

In order to understand the real significance of Einstein's wider doctrine it is essential to have in mind its significance for the theory of knowledge, a subject on which his mathematical exponents are not always clear. Much of the repugnance shown

to accepting the principle of relativity in physics is due to the idea that Einstein is trying to resolve reality into relations merely arising out of the standpoint of the observer. But this is not the case. What the principle, properly conceived, does is to resolve in this fashion relations of shape and measurement but not the actual fact out of which they are differentiated. That fact is the Minkowski 'world,' with its time-like dimension. Such a world may be capable of further analysis by the methods of mathematical logic, and of analysis still more thorough by methods which are of a metaphysical nature.

But for the physicist who has to deal with it Minkowski's 'world,' the manifold or continuum out of which space and time are constructed by the observing mind and differentiated, is itself treated as self-subsistent and as possessing an independent existence closed against the intrusion of that mind. The author of the *Concept of Nature*, Professor Whitehead, does not in that book dissent from this general principle as held by Einstein. He simply treats the principle as one which his method assumes provisionally. This is a convenient assumption for the purposes of mathematical physicists, and if it be borne in mind that the assumption is one only provisional, arising from the application in science of Goethe's maxim that he who would accomplish anything must limit himself, the procedure is legitimate. What, then, is this so-called four-dimensional reality which Relativity-physics takes for its starting point?

Professor Whitehead employs methods in answering this question which carry him further than those of the school of Einstein do, further even than such

writers as Cassirer, Schlick, and Weyl. But his procedure is still that of a mathematician. It belongs, however, to the new domain of mathematical logic as to the area and character of which he and Mr. Bertrand Russell have been so prominent as pioneer exponents. Professor Whitehead, by analysis of the ultimate elements in meaning, comes to what is the final phase of nature for the physicist, for whom nature is in its substance closed to mind. It is what he calls the 'passage of nature,' the changing nature of events not yet elaborated by abstraction from their concrete character into abstractly defined objects. They are the contents of the 'specious present' in which they occupy duration, and extend into as well as supersede each other in the change which is essential in duration. By the abstractions which are constructed in our reflection we shape them into objects, as different in their definiteness from the mere event-world on which they are based as are the space and time of the Einstein relativist from the bare activity in the continuum. If we carry such abstraction far enough, employing what is in effect a method of limits analogous to that of the infinitesimal calculus in pure mathematics, we arrive at instantaneous points and spaceless instants, and at the notions of space apart from time and of time apart from space. But these notions, however valuable and even necessary in directing and shaping knowledge, are only limiting notions, and have no counterpart in any unique or concrete individual objects of experience. It is thus that we come to space and time as relations, not, I think, between events but between objects, shaped by the mind of the individual observer in his reasoned experience. How

far a horse or a dog so shapes the relations of objects is a more difficult question. The animal, in so far as it possesses intelligence, is certainly aware of coincidences and of simultaneities in events, and distinguishes and reasons about the passage of nature in a fashion based on them. But how far its reflection extends is a question on which psychologists have not yet provided sufficient materials for a judgment.

In the cases of individual men each mind fashions a space-time system of its own. These space-time systems are all individual. But, inasmuch as their individualities and consequent differences arise from the conditions under which reflection takes place, upon what in the end prove to be co-ordinates of reference determined by whether the observer is at rest or in motion, and in the latter case on whether his motion is in straight paths or curved, differences in the results of the resolution of the basic fact of the changes present in his awareness result. For us who are men on the earth where the variations in situation and condition among ourselves is so slight as to be negligible, these differences are so small as to escape attention. But when we are observing a region as to which we are relatively in rapid motion, and in which the forms in the gravitational field are consequently different from those which present themselves to us at close quarters on the earth, serious discrepancies between our results and those which have to be regarded as natural to an observer in such a distant region must be taken into account. An observer under these different conditions will analyse the contents of his specious present, of the 'duration' within which fall the events of which he is aware, differently from an

observer on the earth of these events. Differences in shape and measurement will emerge for those who are observing under these varying conditions. The process may in each case seem to those who put it into operation one so natural that they are unconscious of it. None the less is it true that it is a process of inference depending on distinct premises and with distinct results. The man on the earth observing the field of the sun seems to himself to be at rest. He is really moving round the sun at a high velocity, and an observer on the sun must be aware of him as not at rest but as changing position in this fashion. The space-time system of each, as resulting from the analysis unconsciously made, is thus an individual and divergent space-time system. To render these systems into harmony requires mathematical inquiry based on some principle of congruence among them. The constant velocity of light may serve for practical purposes as such a constant. But if the ultimate basis of congruence is to be discovered, and c is to be invested with further-reaching significance, the investigation must be carried beyond the limit to which merely physical mathematical methods can carry it. The final basis of congruence may have to be sought in the foundational character of knowledge, in the light of which it discloses itself, not as any event common to time and space, but as that in which identity underlies all knowledge of difference, and for which alone time and space and the events in them have significance and are there.

Into the larger epistemological problems thus arising neither the mathematician nor the physicist enters. The former directs his methods to the

deduction of wider concepts as the abstract and precise foundations of concepts of a narrower nature. His method is one, not so much of syllogistic inference as of making explicit implications, of further determining a content which is implicit in his propositions. The physicist, on the other hand, is concerned only with the character of the actual in experience. This he defines by observation and experiment, and expresses the result inductively in universals, in the form of equations which are of a nature so general that they cover everything material that can be expressed in point of principle, as the result of observation of the individual objects on which attention is turned. The physicist thus looks for facts in experience as his basis. But he has an ideal in common with the mathematician. The geometry of the latter ought to accord with the generalised observation of his colleague. It is a serious reflection on mathematics and physics if there is a gap between them. The explanation of the difficulty is well stated by Professor Eddington at p. 175 of his book on *Space, Time, and Gravitation.* Speaking of the difficulty of identifying in imagination the abstract geometrical qualities of the world with physical forces, such as those of electricity and magnetism, he asks: "How, for instance, can the change in the length of a rod taken round a circuit in space and time be responsible for the sensations of an electric shock? The geometrical potentials (k) obey the recognised laws of electromagnetic potentials, and each entity in the physical theory—charge, electric force, magnetic element, light, etc.—has its exact analogue in the geometrical theory; but is this formal correspondence a sufficient

ground for identification?" To this question he seems to me to give the correct answer from an epistemological point of view. "The doubt which arises in our minds is due to a failure to recognise the formalism of all physical knowledge. The suggestion 'This is not the thing I am speaking of, though it behaves exactly like it in all respects,' carries no physical meaning. Anything which behaves exactly like electricity must manifest itself to us as electricity. Distinction of form is the only distinction that physics can recognise; and distinction of individuality, if it has any meaning at all, has no bearing on physical manifestations." That is what Gauss and Riemann and the modern school of Einstein have in substance maintained strenuously. There is another name, too, as closely associated with the principle as that of any of the others, and this is the name of Hermann Minkowski.

Minkowski was born in 1864 and he died at the early age of thirty-five under an operation for appendicitis. He was a Russian, whose genius led to a Chair being made for him at the University of Göttingen. As I write, a portrait of him is before me. It is the picture of a very young-looking man, with energy and imagination stamped on every feature. The Slavs are like the Celts in this respect. They may be deficient in staying power compared with us who are of Saxon descent, but for flashes of insight they are hard to match.

Minkowski was a teacher. He was little known in his time to the general public. But when the orations of the statesmen and divines of the West have in the main passed into the oblivion which swallows up what is transitory, there will probably

endure an address delivered by this professor that is likely to be read even three hundred years hence. It was an address delivered on 21st September, 1908, shortly before Minkowski died, to a meeting of learned persons at Cologne. Learned as many of them were I doubt their having taken in much of the deep significance of the words they listened to. The fiery Slav speaker, flourishing only his stick of '*kühne Kreide*,' 'his bold chalk,' and operating with it on the black-board, sought to draw for his audience a picture of the world as in truth four-dimensional, with space and time 'degraded to mere shadows,' leaving nothing of their substance save 'a sort of unitedness of the two.' The burden imposed on the audience was not diminished by the unusual character of the mathematics which the lecturer employed freely. To listen to the address must indeed have been a strain, and yet the occasion was a great one in the history of knowledge. There is an aspect in which the grasp of Minkowski on this occasion suggests itself as of more far-reaching power than any effort to interpret physical reality made before or after his time.

It is worth while to linger over the theme of the orator. For there is underlying it a conclusion which has not always, I think, been fully appreciated—the real reason for the choice of the velocity of light as the constant by reference to which the mathematical physicist actually interprets the varieties of his possible experience.

Minkowski's own view of the general result he had reached may be given in the words used by him as the conclusion of the first part of his famous address: "For the future we shall find in the world

no longer one space but an infinite plurality of spaces, just as in three-dimensional space there is an infinite plurality of planes. Three-dimensional geometry has become a chapter of four-dimensional physics." His purpose was, with the suggestiveness of the conception of a four-dimensional world, to so enlarge the conception of its geometry that this could express all the genuine features of that world. But he was holding firmly the idea that to actual experience of the character of that world geometry must refer back for the test of its own applicability and truth. No doubt geometry is in substance a branch of deductive knowledge. Yet in the end it is found to depend for the truth of its deductions—not merely on the abstract fashion in which they are reasoned out—but on the conformity with reality of its primitive assumptions or postulates. That was why Gauss demanded that a test should be made of the conformity of the postulates of Euclidean geometry to an experimental mensuration of the surface of the earth. To be a science which fits in with the entirety of knowledge the postulates of geometry must accord with exact observation of individual facts. It can resolve into universals as much as it pleases, but it can never in this fashion completely express reality. Back it must come in the end to experience of the object world, and such experience is to be sought, not in the universals of mere logical reflection, but in unique and unambiguous individual objects in perception. We may resolve these into universals indefinitely, but exhaust them we cannot. The logical moment of the particularity of nature will always confront us as a limiting notion which the methods of our geometry cannot eliminate.

In order to compare the space-time systems we discover, and to embrace them for this purpose in a universal system, we require a physical constant, a *c*, to operate with. There must be some ratio between the relations of time and space in change. If the ratio is merely ideal we shall be unable to connect our abstract reasoning with the facts of nature which we wish to express in our equations, and so to reduce these last to precise form with the aid of our mathematical expressions. That is how we come to make such use of what is an apparent constant in observation, the fact of the velocity of light as being uniform for us. Perhaps we may find another such constant in the electro-magnetic field. If we do find another such critical velocity it will equally serve our purpose. We learn from the mathematicians that if our constant *c* is an infinite magnitude we come to a relation between the space and time co-ordinates of a point on a surface which gives that surface a Euclidean or Newtonian character. But such a character cannot be the actual one, for otherwise we should not be able to account for a good many facts which observation discloses. Nor can we do without a definite standard of physical constancy in our *c*. If it is to be our guide in inquiry it must be an individual fact, and cannot be any mere general possibility for reflection. Therefore, declares Minkowski, with a view to surmounting this difficulty, it will not do for science to imagine that we have only to deal with unlimited abstract possibilities within which *c* may be treated as varying from infinity with a minus sign to infinity with a plus sign. For a mathematician who gives free rein to his imaginative capacity will try to discover

whether, in the result, the phenomena of nature do in fact present invariance in the relations of space and time. He will not remain content with theoretically unrestricted logical limits, but he will be compelled to search within a range which is definitely finite, inasmuch as it is restricted to the greatest unit for the '*gewöhnlichen Masseinheiten äusserst grossen* c,' which we find in experience. Such is the interpretation Minkowski's language seems to me to bear. He was not troubling himself over metaphysical difficulties. The velocity of light presents us with a practically limiting fact in our actual experience, and he adds that we may find its analogue in the domain of electricity. He thus brings to a head his exhibition of geometry as an aspect of four-dimensional physics: "Now that mathematics has shown in this connection more ingenuity than usual in laying itself alongside of the instincts of the public, it has at least the satisfaction of knowing that, thanks to its fortunate antecedents in combination with a highly developed sense of the necessity of looking well ahead, it is able to bring together the deep-reaching consequential results of such a refashioning of our conception of nature."

We have now seen why the desire was dominant with Minkowski to base his four-dimensional physical world on observed facts, and why for him no geometry was adequate to the requirements of knowledge which could not provide for this. It remains to ask what this four-dimensional physical world really meant with him. He saw clearly that Newton had assigned an insufficient importance in his scheme to time. Although space and time had different meanings, there was no place in space excepting at a time, and

no time excepting at a place. A space-point at a time-point must be described through four co-ordinates, to give it value as a 'world-point.' The multiplicity of all thinkable systems of value in terms of the four necessary co-ordinates he called his 'world.' In order to avoid a gap in the picture Minkowski makes the (epistemologically) dubious assumption that in every place and at every time there is something that can be perceived, as belonging to such a 'world,' something which may be spoken of as substance, or a substantial point. He assumes that we can not only perceive a world-point but can thus recognise it when it again appears at another time. The outcome of Minkowski's conception is that in the phenomena of nature what we recognise is never anything but the four-dimensional world with three co-ordinates for space and one for time. It can be artificially represented in a diagram showing the lines and curves which result when the relation of the space co-ordinates to the time co-ordinate is varied. If we made such a diagram in accordance with Euclid's geometry all straight lines drawn from the centre of a circular plane surface would have the same measurement, for the standard of curvature would be that of a plane circle. Time does not affect the diagram. But in Minkowski's diagram, as employed at Cologne, the lines representing time and space are not independent in the same fashion. They affect each other, and the standard of curvature of the surface on his black-board is made that of an hyperbola.

The result is that the movement of a point from the origin of its space-and-time co-ordinates has to be expressed differently and means something different

from its character with Euclid. What are called the fundamental invariants in this new geometry nevertheless remain the same when the co-ordinates are moved round their origin. For convenience in mathematical calculation Minkowski substitutes an artificial and imaginary expression for the time relation, which is removed in the expression of the final result of his equations in order to restore to them an exact physical meaning. For physical significance comes back in the end always to the series of real numbers. His purpose is to preserve throughout his calculations the true analogies of form between the space-and-time co-ordinates which are left out of sight in Euclidean representations. In order to exhibit the real relation of space to time it is necessary to provide for representation of the cases where world-points are sending out light to the situation where the co-ordinates originate so as to distinguish them from cases where world-points have received light from that situation as the origin. In the former time will be represented as less than nothing; in the latter it must be greater than nothing. For this distinction his diagrams provide. They show, in addition, cases in which no distinction at all in time can arise.

The diagrams are highly artificial because they present only static pictures. But they show what relations of space to time emerge in Minkowski's doctrine and the principle of fundamental invariance which underlies them. They enable the relations to be made the subject of mathematical calculation, and provide for the possibility of comparing the results in different systems. In any event they show how changes in time must be taken into account as of equal importance with changes in space in the descrip-

tion and the estimation of the significance of physical phenomena.

Minkowski himself did not adopt the expression 'Relativity' for the outcome of his postulate of the necessity of going deeper down than appearances suggest for a foundation of invariance in the relations of his world-points. "Inasmuch," he says, "as the meaning of the postulate is that in phenomena we find only the four-dimensional world in space and time, but the projection in space and time can take place with a certain amount of freedom, I prefer to give to my statement the title of 'postulate of an absolute world,' or more shortly 'world postulate.'" The important points in his theory are from the outlook of philosophy two. First of all he pronounces for a so-called absolute world of which we are aware and which we can describe apart from relativity in measurement with the precision which mathematical methods permit. In the second place, the description is one which consists, not merely in resolution into the abstract universals of mathematics, but in direct reference to actual physical objects in a condition of change, such as the changing path of a ray of light, which are individual and unique in character. This is no mere geometry. It is physics. A pure geometry would be altogether deductive. Even Euclid's geometry is not pure, for it turns on postulates about the character of space which can look for any verification they possess only to experience. Such verification has now been challenged. It is said that the postulates on which Euclid relied do not conform to the nature of the real world.

The existence as a self-subsistent entity of such a four-dimensional world,* taken as present to con-

sciousness apart from any moulding interference from the observing mind, is the postulate on which the modern doctrine of relativity builds. If methods of a logical and metaphysical order are applied to its investigation such a world may turn out to be further resoluble by reflection. But with the complications such methods might disclose the physicist is not concerned. He treats the four-dimensional world as 'closed to mind.' It is for him absolute, and its fundamental characteristics are to be the same for all observers, however situated and whether at rest or moving. But these characteristics are of a very general character, antecedent to shape and measurement. They depend on functions of the relations to each other of the world-points. Such functions are made capable of differential expression by applying to them the doctrine of tensors. The possibility of doing this and of so arriving at relations that are invariant, however the time-and-space co-ordinates of situation in the world as experienced mould each other, affords the footing on which the results of such moulding, and the varying appearances in the different space-time systems which arise for perception, can be compared, rendered congruent, and reduced in calculation to each other's terms. The abstractions of mathematics are thus sought to be made applicable to the unique and individual natures of the objects of perception, and a large part of mathematics itself becomes a deduction from the results of observation of the actual world. The assumption of Newton that his space and time were actual but unchanging frameworks in which the objects of nature exist is accordingly replaced by the principle that there is an indefinite multiplicity of space-time systems which

depend for the shapes and measurements that appear in them on the relation of the observer to what he observes. It is where there is practical uniformity in this relation, as in the case of most observation by those on the earth of objects, that the space-time system appears to be the same for all observers. But wherever differences among these in situation and conditions exist on a considerable scale, as in the cases of calculated results of observation by observers in different positions in the firmament, the space-time systems may vary materially, with practical consequences.

What we really apprehend when we eliminate by abstraction the elements that we ourselves have contributed is therefore, for Minkowski and the school of Einstein that agrees with him, a 'passage of nature,' a series of changing events in which objects with the definite relations which are what we mean by space and time have not yet been constructed. Our constants in such comparison as this mere awareness admits of are not yet shapes or measurements. Nor, inasmuch as what we are seeking to describe is a concrete world, can they be mere mathematical deductions. These constants must be sought in a phenomenal domain where we can find changes of a kind critical in this respect, that their magnitude is recognised as being in each case a limiting one for our observation. In so far as these magnitudes cannot in point of fact be exceeded they are treated as if they were individual and unique facts, which we can employ as standards capable of being referred to in comparison and as bases in calculation. When we measure them we use in part deductive methods based on the assumption that they are final and

constant. The measurements must always come out with the same result, inasmuch as they consist in no more than expressions referred in the terms of the varying space-and-time relations of the observer to the unique and final fact which he is observing. The space-and-time calculations will be expressed differently as the systems of the observers differ. But if they are true calculations they must, by their very nature, yield just the same outcome about the relative measurement of the change observed at the outset, however different may be the significance of the space-and-time units in which that outcome is expressed. That is why Morley and Michelson, and all other observers who since their time directed experiments to the point, have found the velocity of light to have a constant measurement of about 186,300 miles a second. No doubt much has to be said about the interpretation of the miles and seconds and their relation. But the cardinal feature is that the measurement not only does result, but on the principle of a four-dimensional world must result, in formally invariant answers to the question put.

We never see space unmoulded by time or time unmoulded by space. Instantaneous space, a pure collection of static points, is a convenient abstraction for the purposes of the mathematician. But the physicist observes nothing of the sort, and if, *per impossibile*, he could he would retain no picture of it in his consciousness. What we observe, and what alone we can image to ourselves, is a change or passage from point to point in which points are distinguished. It is the same with time. Get rid by abstraction of separation in space, and there is a

mere empty series, in which the only distinction is a merely numerical one between names for what is, what was, and what may be. Minkowski exhibited this by means of a highly artificial diagram to which reference has been made, and showed that if an attempt were made on a purely mathematical and deductive footing to apply it for the description of all conceivable rays moving in the world of actual perception, with the critical velocity which we experience in connection with light, a further case would occur. There would be of necessity excluded from our possible experience regions in which we could not have the velocity of light as a standard. Such regions are mathematical constructions which point beyond possible experiences. They are instructive. But they belong to the aspect in which knowledge passes beyond what is actual, in its process of analysing only through abstract distinctions which knowledge itself establishes. For Minkowski, as for Einstein, in the system of the actual world it can be demonstrated that a velocity greater than that of light is impossible. This is a result which follows from the principles on which their kinematics are based. There has been a good deal of complaint about it. People refer, for instance, to the *beta* rays of the radio-active substances, which appear to possess a velocity which may approach that of light, and ask why these rays cannot become so accelerated as to exceed in their velocity that of light. But the school of Einstein reply that the mass of a material particle, and therefore its inertial resistance, can be shown mathematically to tend to become impossibly great in proportion as the velocity of the particle approaches that of light, and that the attainment of

the latter velocity can be proved to be on this account impracticable. Our ideas, not only in kinematics but also in dynamics, have to be refashioned because of the new conception of our world. The refashioned dynamical principles, as held by the adherents of relativity, allow of mathematical proof that the inertial resistance of a moving particle to acceleration by means of any finite force is such that this resistance increases to infinity and precludes the attainment of the velocity of light.

THE PHILOSOPHICAL SIGNIFICANCE OF OTHER SUBJECTS

CHAPTER VI

MATHEMATICAL PHYSICS (*continued*)

THE four-dimensional world is the bridge between a domain of abstractions and a concrete world filled with individuality as perceived. Stationed on this bridge Einstein and his disciples look impartially in both directions. But it is now evident why they refuse to separate geometry from mensuration, and why they lay such stress on facts of actual experience, such as the velocity of light and of energy manifesting itself in the electro-magnetic field. What Gauss was straining after when he introduced curvilinear co-ordinates for the ascertainment of the positions of the points on every kind of two-dimensional surface; what Riemann grasped at when he enlarged, as he did, the limits of possible conceptions of space and of its geometry, has been brought, in the view of Einstein and his disciples, within their reach by the introduction of the continuous manifold of the four-dimensional world.

We can now see the real step forward which Einstein seeks to attain by his general theory. He has Minkowski's space-time world of change before him. This gives him the facts of nature so interpreted to apprehend in their fundamental relations. Change in the position of bodies relatively to each other was explained by Newton as motion in an independently existing Euclidean space. But every

such change of position of this developed kind may arise equally, so far as its appearance in our experience is concerned, if we assume that it is the observer who has changed position while the object observed has remained at rest. The apple appears to fall to the earth. But if the earth itself, with the observer on it, were moving with accelerating velocity it would overtake the mere inertial motion upwards of the apple, and so produce the appearance of its falling. If the reality of what is happening must be sought in a four-dimensional continuum, where relative and measurable rest and motion are unmeaning and unbroken change is a basic characteristic, the actual truth may lie just as well in the latter explanation as in the other, which depends on the assumption that the earth and the observer are definitely at rest. The sun appears to go over the earth in a curve, and was generally believed to do so for many centuries. We now know, but only by inference and as the result of interpretation, that the earth goes round the sun. So, it is said, it can be shown of every such phenomenon of nature that it is at least capable of Einstein's alternative explanation.

Gravitation is not different from inertial motion. They are equivalent, if we bear in mind that they are equally open to the alternative explanation which reduces each to an illustration of the other, disguised by the circumstance of the observer being himself arbitrarily in motion. Now Minkowski, as well as Einstein, has shown us that the ultimate world is one which may be interpreted as a series of world-points in activity or change. It is by making assumptions as to rest and motion, which really are assumptions as to the rest or motion of the observer,

that we have got by abstraction to our conceptions of space and time as independent of each other. They have in truth no independent existences. They are ways in which we treat reflectively the world of changing point-events which we are to hold to as final physical reality. Euclidean geometry is just one out of many possible ways of doing this. Theory and experiment alike (such as were the experiments of Eötvös already referred to) point to the wider conception of relativity as the possible explanation of many facts. One thing which what we call direct awareness discloses to us when we eliminate our theories is the coincidence in time and space of material points at the same time and in the same space. We cannot even say of a line, when we attempt to describe it merely by such coincidences, whether it is straight or otherwise. For that implies standards which bare coincidence does not warrant. If we examine the procedure of the exact sciences we find that all their definite determinations arise by assuming at least the principle of such coincidence. Every actual measurement proves in ultimate analysis to be a demonstration that a point coincides with another point on something resembling a scale. Whether the measurement is of length, of time, of force, of mass, of electrical current, or of chemical affinity, it is always the same: all determinations are of coincidences in time and space. In the language in which Minkowski describes his 'world-points,' they are identified through the encounters in the space-time manifold of world-lines, and physics is the science of the relations of the points so identified. The doctrine of Minkowski seems, as he stated it, to be expressed more pictorially than the stage he is dealing with

warrants; but in point of principle it is hardly different from the result reached in his analysis of the passage of events in nature by Professor Whitehead. Both seek to reach reality by stripping it of artificial incrustations with which it is invested by the minds of particular observers. It is these incrustations which the principle of relativity peels off.

Impressive as the writings of Minkowski are, by the freshness and power of his statements, they suffer from the defect earlier referred to. His wonderful command of mathematical instruments tempts him too often to try to express in the shape of diagrams the relationship of the time and space which he has reduced to 'shadows,' and which involve each other conceptually inasmuch as they spring from a common root. These diagrams are of course only spatial, and convey nothing excepting symbolically of the character of that change in which time consists. Moreover, as Minkowski is essentially an empiricist, in so far as he is aiming at exhibiting three-dimensional geometry as a branch of four-dimensional physics, it is to experience that he comes in the end for the constants that the principle of congruence which is essential for him necessitates. These he finds in maximum velocities which we cannot get beyond in an experience of the character of our own, the velocities of light and the electro-magnetic field. Conceivably there may be more general constants. Pure mathematics can suggest and deal with such hypothetically. But in so far as it does so pure mathematics is a deductive and merely logical process based on what is unverifiable in the world of reality. Accordingly Minkowski avoids hypothetical constants and bases his reasoning on relationships to those which he finds in experience.

He is careful to confine himself within this limitation. But his diagrams and some of his mathematical expressions of a different kind have given an impulse to a good deal of talk which goes outside the limits which the method imposes. If we are dealing with a maximum velocity, such as that of light is found in observation to be, it is quite true that we have before us, as he suggests, a complete line of demarcation between the past and the future. But this is in reality an empirical or practical demarcation, and is not in itself one which guides towards the conception of a reversal of the history of events, or to any timeless or neutral object world. Much more of new principle than what relates merely to measurement of position is involved in such a conception. While it is true that there is in our experience, possible as well as actual, in one sense no absolute simultaneity any more than there is absolute motion, this has its significance as due to the unavoidable intrusion of relativity into the observer's procedure. There is another sense in which, in the ultimate four-dimensional world, there is both absolute simultaneity and absolute change. These may be only limiting notions, but experience implies them as notions on which its significance and reality are ultimately based. It seems, therefore, dangerous to speak of events as causing events in their past; there appears to be here confusion between the different characters which belong to what are physical and, therefore, arbitrary standards, and to what are really general and theoretical constants. The structure of possible experience, assuming that it is to be regarded as if made actual, does not seem to admit of such a merely mathematical representation.

Perhaps the very enthusiasm with which Minkow-

ski expressed himself has given rise to a tendency in his school to go beyond what he himself said. At all events, some of his disciples have been careful even when they seek to follow him in his principle. One who knows his work well and is among the most distinguished of these disciples has been cautious in this respect. There is a suggestive attempt at description of the four-dimensional world in a book to which I have already referred, *Die Relativitäts-theorie Einsteins*, by Professor Max Born of Göttingen, a second edition of which has recently appeared. Prof. Born is not only a physicist but a mathematician, with grasp of modern methods of differential analysis. It seems useful to state the way in which he has formulated the Minkowski-Einstein position, even without including all the diagrams and equations which Prof. Born uses.

At page 238 of his book Professor Born observes "that the totality of marked-out world-points is what is determinable in the actual. The four-dimensional continuum is in itself devoid of structure; it is only the factual relations of the world-points in it which observation discloses that express in it what corresponds to measurement-relation and geometry. In the world that confronts us we have, so far, the same conditions that we have learned to recognise even in the geometry of surfaces. The mathematical method of treatment is accordingly the same in each. Suppose that we introduce Gaussian co-ordinates into our treatment of the four-dimensional world, we construct a network or mesh-system of marked-out world-points. It implies that we may think of space as filled with matter arbitrarily in motion in all directions, matter which may turn and deform itself, but

always preserves a continuity in its relations; it is what Einstein has likened to a kind of mollusc. In this domain we draw three sets of lines cutting each other, which we number and distinguish by the letters x, y, z. In the corners of the net of meshes which is so produced we now think of clocks as placed. They may go at any rate so long as the differences between the results of clocks that are very close to each other in space is very small. The total system is now not a rigid one; it is an altering mollusc of relations. In the four-dimensional world there corresponds to it a system of Gaussian co-ordinates, consisting in a network of four-numbered surface sets, x, y, z, t. All moving rigid relational systems are naturally just special forms in this self-deforming relational system. It is meaningless from our general standpoint to regard rigidity as something given *a priori*. Moreover the separation of space from time is wholly arbitrary, for just as the rate of the clocks is wholly arbitrary and cannot be assumed to have more than a principle of continuity in its change, so the space itself, as no more than the totality of all simultaneous world-points, is likewise without physical reality of its own. For if the Gaussian co-ordinates were chosen differently the world-points that were simultaneous would be different. What, however, do not change in the transition from one system of Gaussian co-ordinates to another are the points in which the actual world-lines intersect, the marked-out world-points which exhibit for our reflection coincidences in time and space. All the actually determinable facts of physics are thus qualitative relations of position of these world-points, and they remain unaltered by the change in the Gaussian co-ordinates.

"Such a transformation of the Gaussian co-ordinates of the space-time continuum means the transition from one relational system to another arbitrarily deformed and moved. The satisfaction of the demand that we should assume in the laws of nature only what is actually ascertainable involves the postulate that these laws must be found as *invariant when arbitrary transformations of Gaussian co-ordinates*, x, y, z, t, *are made into others*, x^1, y^1, z^1, t^1. This postulate obviously covers the general principle of relativity, for among the possible transformations of x, y, z, t are those which express the transition from one three-dimensional system to another in any kind of motion. But the postulate goes further, in that it includes also arbitrary deformations of space and time. It is in this way that we come to the foundation of a general doctrine about space, on the basis of which alone the principle of a complete relativity can be carried out."

This passage in Born's book illustrates the interpretation he has put on the ground conception of his predecessor at Göttingen, Minkowski. In agreement with the latter he claims to be describing the four-dimensional world, not as a mathematical abstraction, or even as a geometry based on *a priori* postulates about the nature of space, but as indicative of the ultimate source of our experience. He goes on to show the relation of this character to the general principle of relativity as formulated by Einstein. On his exposition of this last the space at my disposal only permits me to touch briefly. His task is in the first place one mainly of pure mathematics. The interval between two world-points expresses what corresponds or is at least analogous to a space-and-time relation in the four-

dimensional world. Its characteristics will vary with the relation in which what corresponds to space and time in combination occurs there. An equation can easily be found which will define this relation if co-ordinates can be assumed represented by Euclidean straight lines, e.g. in regions where there is no gravitational field apparent. There the special theory of relativity for the relations which obtain when systems are in rectilinear and uniform motion relatively to each other, and the Lorentzian formula for transformations, hold good. The equation expresses a principle which would then be completely invariant in all such transformations. We could even apply it to sufficiently small fractions of a curved surface. But we must not forget that we are really concerned with intervals in the continuum which are of the nature, not of straight lines, but more generally of geodesic lines, the directest possible, but depending in point of form on the character of the space-time region in which we find them. We are not to think of this as flat space or as an independent entity in which lines are artificially carved out in curved form. It is rather itself curved by its nature. A ball when thrown from the hand gravitates towards the earth. The Newtonian explanation by the action of a gravitational pull may be replaced without theoretical difficulty by the conception of the space itself as exhibiting a relation of curvature created by the accelerated motion of the observer and the earth on which he stands. There are no absolute paths or shapes any more than measurements. In the four-dimensional world all is in a state of change, and this will account for the appearance of gravitation and its identification with inertial motion.

All such diversities in motion are actual facts for observation, and they supersede the hypothesis of a pulling force acting at a distance, which is no longer essential so soon as we understand the circumstances fully. A geodesic line is no straight line in Euclid's sense. Euclid made an assumption of finality in his axiom of parallels for which observation afforded no real warrant.

So soon, therefore, as we turn to the infinite varieties of curvature which the geodesical possibilities of the continuum offer we have to look for a less restricted equation for the description of the interval than that which suffices when the spatial relation is conceived as Euclidean. Such a Euclidean line can no longer be taken as the standard to which the intervals conform. For their continuity we must now look further. With space altering its form in its combination in change with time we can, by applying what are analogous to the curved co-ordinates introduced by Gauss, reach a new standard. The geodesic lines may vary in curvature, but if they do so with continuity of a general character formulas can be found which will express the invariant quality or relation in this continuity of character. Such formulas have been discovered by the researches of pure mathematicians. I have myself ventured to attempt a slight, but only a slight, account of them in chapter v of *The Reign of Relativity* and it is not necessary to pursue the subject further here. Those who desire to enter into details will find them, not only in the books there referred to, but still more fully in Professor Weyl's treatise on *Raum, Zeit, Materie*, to which reference has already been made.

The outcome of the matter is that, just as in the

theory of surfaces the structure was composed of what could be called geodesic lines, so here in the four-dimensional world we figure to ourselves geodesic lines which represent the shortest or most direct intervals between the world-points in the space-time continuum, and the invariant character which these intervals possess enables us to compare them. For quantitative measurement in space and time we have to resort to observation and experiment for our materials. But an equation of a tensor nature gives a result which is invariant, however the measurements and its systems may differ. This result is free from relativity. But just on that account it can be no more than a framework into which the actual measurement is finally built. Through the instrumentality of a tensor expression which is covariant for whatever particular quantities are introduced as the result of observation, we become able to render congruent and so comparable the phenomena of different systems of relativity.

Such appears to be the basis on which Einstein has sought to bring together physics and geometry. Minkowski's deposition of space and time from the status of independent entities seems to have fitted in completely with his own principles. When Einstein introduced his new idea of the gravitational field he effected a great revolution. The assumption of a force pulling at a distance became, conceptually at least, unnecessary. It had always been unintelligible, and it was now replaced by the view that all we observe is change in positions relatively to each other and particularly to ourselves, the observers. This required new conceptions of space and time, as no longer objectively self-subsistent, but as relations

into which we resolve change, which is what we really observe. Thus space-time systems presented themselves as varying with the situation and motion, accelerated or uniform, of the observer. Gravitation and inertia became different appearances of the same fact. Then it was evident that the principle of relativity must be extended to the idea conveyed by mass. For energy became capable of a natural interpretation in terms of variation in the path of its radiation. Mass displayed itself as simply a form in which energy appears, and matter became, no more indestructible substance, but merely concentration of energy. For example, it has been shown by Sir J. J. Thomson that, if a conductor charged with electricity has to be moved or stopped, additional force will be necessary simply on account of the charge. For the conductor has to carry its electrical field with it, and force is needed to set the field moving. This electrical field is inertial, and its inertia is indistinguishable from mass. More energy introduced adds to the mass. Is there any other meaning than this in mass? For the general theory of relativity, in which electrical and magnetic fields as domains of causal activity display merely manifestations of energy, the phenomena of inertia of mass must always appear. The electron and the atom become illustrations of the principle. We arrive finally, after yet further mathematical analysis, at a highly general conception which it is suggested should be called *action*, as descriptive of the fundamental reality in physics. There are restrictions on the theoretical possibilities as regards the relation of mass proper to energy. For example it is demonstrable, as has already been observed,

that the amount of its mass in the case of a moving particle increases in proportion as its velocity approaches that of light. That is because mass is not different from motion and increases with it. The appropriate equations show that where the velocity tends to equal that of light the mass will approach infinity. It follows that it is impossible with any finite force to give the particle a velocity which can exceed that of light, for its inertial resistance would in that case be infinite and prevent it from attaining to such a velocity.

These are some of the questions which the investigations of Einstein force upon us. There remain points on which much work has yet to be done. One of these at least is far-reaching. The modern conception of the atom suggests that light is the outcome of the production by electrons inside the atom of waves of energy which proceed in every direction. For such a phenomenon physicists used to be content with the formulas which have been current since the introduction of Maxwell's equations. Of late many physicists have felt compelled to give up the adequacy of these formulas as sufficient for description of what happens inside the atom, and to assume other laws, formulated by Max Planck in 1900. These are the laws belonging to the *quantum* theory. They have been developed in their application by physicists such as Bohr, and an account of the general considerations which make some such principle seem inevitable will be found in Mr. J. H. Jeans's recently published *Report on the Quantum Theory*. Here we come on discreteness, to use a term which has one meaning in logic and a different one in mathematics (a difference to which reference will be made later on), in the

aspect of the four-dimensional world which can no more be neglected than can its aspect of continuity. How far the character of such phenomena is susceptible of having light thrown on it from epistemological considerations is a question which I have already mentioned. It may be that the general character of experience is such that continuity is logically impossible apart from discreteness, just as time has even in logic no significance apart from space. The unique quality of the actual in experience and the consequent impossibility of exhausting it by the universals of science suggest such considerations. The general theory of relativity would hardly be an adequate description of our actual experience if it asserted only continuity in the phenomenal world.

It is material to the strength of Einstein's position that it is just this assertion that he does not make. His doctrine is one which is no abstract mathematical idea resting in the air. It is a development of ideas gathered from an experience which has merely been simplified when described as one ultimately concerned with the form of structure of the four-dimensional world of experience, an actual manifold and also a continuum. This structure is characterised by discreteness as much as by continuity. Its phenomenal quality is that of the individual and self-contained object in knowledge. It is not to the point to say that it is a world of which we never ourselves have actual experience. If this objection were a good one it would be fatal to progress in exact physical science. The application of all methods depending on *limits*, which cannot be considered as more than vanishing relations or rates of change, would be excluded in inquiry into the real nature of experience.

But such methods are essential in modern science. They deal, it is true, only with general characters and are not exhaustive, but they alone enable us to ascertain the full significance of what we observe. They guide us towards macrocosmic principles by which we interpret the individual objects which we encounter in empirical knowledge. They enable us to predict possibilities in developed observation, and tell us what we may exclude from the region of the possible. More perfect instruments and better conditions may enable the observer to become directly aware of objects which under existing conditions he cannot reach. But the abstract deductions of the mathematician do more, for they limit the region of the possible and direct the observer to what alone he can with hope of success search for.

Mathematical investigation into the character of reality often does more than this. It alters for us the significance of what seems to appear, and banishes false and distorted images of the possible. Einstein's teaching, for example, has made it unnecessary for us any longer to attribute to space an independently self-subsisting nature, such as might admit of its being regarded as a *cause* of physical happenings. It is no more necessary to-day to give it such a character than it is to believe in a real contract when legal theory, in order to secure justice by means of a fiction which no suitor in the Courts of Justice is allowed to traverse, imputes a contract which everyone knows never to have been actually made. For space conceived as the field required for causal action most mathematical physicists are now content to substitute change in the position of a moving observer, relatively, it may be, to a background of distant masses like the heavenly

bodies, as the explanation of what appears differently to the observer who assumes himself to be stationary. It is the same with the apparent interaction of molecules. What is popularly meant by causative action at an even infinitesimal distance is a conception no longer required in physics. But we may still talk in familiar Newtonian terms, if we remember that they cannot be ultimately relied on as guides. There is convenience in so doing, for Newton's results approximately conform to most of our experience. We may even speak of the 'æther' if we bear in mind that the only scientific significance left to it is that of the empty and varying spatial system which forms the scene of gravitational and electro-magnetic fields. But such an æther is no substance. It has no independent existence. It has no fixed and unalterable points or paths in it. It does not admit of being described as anything to which by itself motion is relative. It is just a *nomen collectivum*, to which Einstein himself does not object if its only real meaning is kept in memory.

The theory of relativity in its wider significance is thus a further attempt which science has made towards the interpretation in terms of universals of an actual world. It is no mere collection of mathematical abstractions, deduced from general principles. It is a new interpretation of the meaning constitutive of reality towards which we have been driven by observation of the actual. It has brought us to see that the part which mind plays in the fashioning of our knowledge of what we call facts is larger than we had supposed. The relativity of such knowledge becomes everywhere

apparent and account has to be taken of it. But the character of such relativity can now be in part explained and its variations can be reduced to principles. The method is just the same as that followed in a developing fashion by science since the days of Bacon. The history of the genesis of Einstein's theory is an illustration of how science never stands still, but is always being impelled by reflections of a dynamic nature. But scientific knowledge is not the less scientific knowledge because it does not stand still.

Hitherto we have been concerned with the world of physics and therefore with reflection belonging to a certain order in knowledge. It is the standpoints to which that order is confined that give to knowledge in it the character of relativity in a deeper sense than that in which Einstein and his disciples use the word. Just as we refuse even from a scientific point of view to try to bifurcate nature after the fashion of the Victorian physicists; just as we decline to try any more to draw a line separating objectivity from subjectivity, or primary from secondary qualities; so we come to regard the actual aspects which nature presents as representing, not self-subsisting entities, but standpoints within the entirety of knowledge.

Even if we take the view that the work of the school of relativity in mathematical physics is of too limited a character in itself to throw all the light we require on the nature of knowledge, it has opened up the character of its procedure. I do not refer to the specific achievements of the school of Einstein. These may have to be remodelled as research goes on. Even if, for instance, the work of Weyl (to be referred to presently) in setting up a fresh and more general theory of the character

of interval relations is superseded, we shall have gained much from his attempt to enable the laws of the field of electro-dynamics to be referred to electric charge as the reality behind gravitation and the appearance of the world in space and time. For he, like Einstein, has brought to light in a fresh fashion points to which attention must be given if what is actual is to be fully explained, distinctions forced upon us between our relative and arbitrary identification of events and their measurement, and certain intrinsic qualities which do not vary either in these events or in our particular measurements of them with the altering standards of observers. Mathematicians have taught us that such distinctions must be made, and they have further taught us how to describe sufficiently these intrinsic qualities by the introduction of tensors. This method enables us to separate what is merely relative to the position of the observer in the results of his observation from what is not relative but always the same. It does not carry us to any pictorial or actual view of reality. But it does enable us to generalise in a way that would not otherwise be possible, and to gain new knowledge of the intrinsic character of the actual by a resolution into universals of a kind much farther-reaching than was possible before the tensor method was discovered.

This, however, is only one of the great examples which the most modern mathematics offers to the would-be student of the nature of knowledge. A familiar illustration of new ideas has been already referred to. The principle of what the Germans call *Nahewirkung*, action at infinitesimally close distance, has been introduced into the study of physics with tremendous consequences. It has been equally

familiar, as we saw, in the study of pure space since Riemann adopted it for that purpose, and it now extends to time, since time and space are no longer treated as separate entities, but rather as abstractions made from different standpoints in the consideration of a four-dimensional world.

The question is whether the lessons so taught are without application when we come to aspects of nature other than those which belong to mathematics and physics. One thing is clear. In all cases we are in search of what we call laws of nature, uniformities which have to be explained as consequences of reasons of a general character. We can only study the phenomena in their unique individuality by describing their characteristics in the language of universals, and this means that we must seek for relations that are not individual merely but general. Adequate concepts are therefore essential. We have to try hypothesis after hypothesis, based on such concepts, by the test of their fitting the individual facts which have to be explained. But if, as I have sought to show in *The Reign of Relativity*, knowledge has many standpoints from which the object which is relative to it is always moulded, then the conceptions chosen as the bases of hypothesis must be such as are appropriate to the particular standpoint from which we are observing. The entirety of knowledge seems to consist in a plurality of general standpoints which belong to different orders in thought. These orders must not be confounded. Nor can the categories appropriate only to one order be employed when we are dealing with problems which belong to another. It is failure to remember this which has led to the contradictions that arise when mind is treated as a

thing and knowledge as its property. The same sort of contradiction arises when, by the employment of conceptions which do not fit the facts, we try to describe what is living as a mechanism. The essential feature in mechanism is externality to each other in space and time of the components. Even in physics infinitesimally conceived this is strictly true. Cause and effect and change in the form of substance resulting from their action are the relevant categories. They are not the less the categories of the relevant standpoint when we succeed in exhibiting matter as simply a form of energy. What is characteristic in the general relationship is that, in ultimate analysis, what we call the cause when completely described is indistinguishable spatially and temporarily from its effect. Yet our standpoint makes us treat them as separable entities in the field of action, even when we look on that field as really four-dimensional.

Before concluding these observations on the doctrine of relativity in our measurement of space and time it seems right to refer to another recent development of that doctrine. In chapter v of *The Reign of Relativity* I drew attention to the philosophical significance of the tensor method. The tensor method is capable of extension in a variety of ways. Its object is the elimination of the irrelevant by bringing the object in a highly abstract fashion under a very general yet exclusive concept. For instance, we can partition space in many different ways, by employing co-ordinates which may be rectangular or polar or oblique or straight or curved. The space-systems so fashioned will consequently vary, and so will measurements and mesh-systems based on the co-ordinates.

But there are mathematical formulas which are applicable for description of the character of an indefinitely small interval in space, although the coordinates and the measurements and mesh-systems employed differ in different sorts of space. Such formulas teach us the character of space independent of shape and measurement in it. There are characteristics of space ascertained by this sort of abstraction which enable us to discriminate between intrinsic characteristics of space constant under varying conditions, which are antecedent in logic to shape and measurement, but which must be ascertained if we wish to ascertain completely the nature of the space we are dealing with. The same thing, *mutatis mutandis*, is true of time. Shape and measurement in both space and time depend on the perceptions of the observer and his situation and conditions. But the general character of his space and time may be of a kind that is invariant, while the results of his observation will have different meanings according to the particular space-system in which the observation takes place. There was formerly failure to take account of this. That was why, when the eclipse of the sun took place in 1919, the rays passing from the distant stars were found to be deflected differently from what the ordinary physicist had predicted. He had not allowed for variation in the system in which the phenomenon would have to be observed. The law of gravitation, which applies to light on the principle of relativity, as much as it applies to what is popularly called matter, is indeed for Einstein a law which in its general form holds whatever the special position of the observer may be. It defines the geodesic line of a particle, regarded as if attracted

by gravitation to another, as describable in terms of the character of the four-dimensional world, the space-time continuum. The description is given with the help of a tensor equation, which expresses the relation of an event-particle to an indefinitely close event-particle. The equation is based on the characteristic functions of the co-ordinates of one of the event-particles, and assumes continuity or invariance in the fundamental quality of the space-time, treated as being what physicists call 'absolute.'

But here a doubt has come in. The attribution of continuity or invariance in the underlying quality of the space-time with which the physicist is dealing is the outcome of his differential method, which is concerned with the infinitely near. If all we had to deal with were two infinitesimally close space-time systems, the real character of which was that of limiting notions inseparable in some logical order, it would be natural to assume continuity between the space-time of the point-event we started from and space-time infinitely near it. This may be a legitimate assumption in answering questions arising out of Einstein's theory of gravitation. But can we properly assume invariance of character when we have to compare the intervals in two sets of such points if the sets are at a finite or observable distance from each other? Can we assume that if we transport whatever is the equivalent of an infinitesimal rod or clock for measuring coincidences from one position to another at an actual distance from it, the measurements we obtain will be based on the same fundamental character for both parts in space? In the first instance, we know that they cannot, because the shapes and measurements must

be dependent on the observer and how he is related to the object. But can we in this case eliminate these variables as physicists have become able to do in the case of gravitational fields, by estimating fundamental qualities which are invariant for all gravitational systems? For the new problem of comparing intervals distant from each other we cannot apply, in the same fashion at all events, the limiting notion of the infinitely near. It may prove necessary to bridge over the distance between the intervals to be compared by determining in a complete chain each of the intermediate intervals separately and ascertaining a definite unit of interval at every intermediate point in the continuum. For only if we can do this shall we be brought back to the geometry of the infinitely near and that continuity in fundamental character which is the foundation of the tensor system. The intermediate intervals may vary and yet preserve continuity in their variations if only their relation of position as regards each other is in each instance a continuous one. If that be so a further calculation will be possible, in which the particular character of each successive interval, what is sometimes called its 'gauge,' is made amenable to tensor treatment. Now the problem is by no means a merely speculative one, as to whether there is latent an untested feature in Einstein's method of estimating the underlying character of space and time. It is a practical problem. For the characteristics of the electro-magnetic field apparently render it necessary to consider the question definitely. Weyl, in his book, *Raum, Zeit, Materie*, already referred to, has been a pioneer in this region. He discusses it at pp. 257-8 of the recently published Fourth Edition

(cf. the Eng. Trans. at p. 282). Starting from the proposition that in nature we know no really fundamental expressions of force excepting those of gravitation and of electrical energy, he says that the physical science of our time renders it plausible that all the other expressions of force can be built up indirectly out of the intermediate values of these two. The result will then be that the world is a $(3 + 1)$ — dimension metrical manifold, and that all the phenomena of the physical field are the objective expressions of the metrical qualities or structure of that world. He is willing to use, as synonymous with the word 'metric,' the phrase 'condition of the æther' in order to emphasise the objective character of the metric; but no one must build up a false picture from the employment of this phrase. The terminology employed just affirms the ground-principle of infinitesimal geometry, that the field of direction, and along with it gravitation, vary with what may be called in guarded language the condition of the æther. The antithesis between 'physical condition' and 'gravitation' is sought to be transcended in the new conception, and a completely unified standpoint is attempted. Variation of relativity in magnitude in co-ordinate systems must be added to that as regards motion of Einstein. What we call matter is to be exhibited as mere metrical structure. Descartes' dream of a purely geometrical physics is to be realised in a fashion of which Descartes himself never dreamt.

"Newtonian mechanics," says Weyl, "and also the special theory of relativity, assumed that uniform translation is just a specific condition of motion in the intersecting points of axes of vectors, and that the

position of the axes at one moment determines their position at every other moment. But this is irreconcilable with the plainly appearing principle of the relativity of motion. Yet, without coming into gross conflict with facts, we can satisfy this principle, only, however, if we hold fast to the concept of the *infinitesimal* displacement of a vector set of axes as if a parallel one. But we must regard the *affine connection* which the displacement defines as something physically actual, standing in dependence on the condition of matter because of a law of nature obtaining in it (the field of direction). The property established empirically in the case of gravitation, the equality of inertial and heavy mass, shows finally that in the field of direction gravitation is contained as well as inertia. It was thus that the general theory of relativity obtained a specifically physical meaning in addition to its original meaning in the geometry of the world. On just as good evidence as the relativity of motion is based the principle of the relativity of magnitude. We must have the courage to hold firmly to this principle, according to which the magnitude of a body at one moment does not define its magnitude at another moment, and this notwithstanding the existence of rigid bodies. But no one is able to do this without coming into gross conflict with fundamental facts, if he is not at the same time prepared to hold firmly to the concept of *infinitesimal* congruent extension; that is to say, we must ascribe to the world, in addition to its determinations of measurement, a *metrical* connection in addition. We must, however, see in this no geometrical property, which belongs to the world only as a phenomenal form, but an actual state of the field of physical reality."

It is for this reason, he suggests, that we are driven by the facts of the spreading character of action and of the rigidity of bodies to base the *affine* connection on what lies at a deeper level, a fundamental *metrical* property of the world. And we are brought into sight of the identification of certain co-efficients with electro-magnetic potentials, just as we have identified certain others with the potentials of the gravitational field.

I have cited Weyl with no intention of being so rash as to indulge in speculation as to whether he is right or wrong. I wished simply to show the extent to which mathematicians are trying to interpret physical phenomena in terms of universals. Weyl goes beyond Einstein, while accepting the general theory of relativity. Einstein, he says, assumes that in the transference of distances by congruent transference we are dealing with what is integrable and that intervals at finite distances can be compared on the footing that their magnitudes can be expressed in terms of each other. But this, for Weyl, is just as much in conflict with the principle of the relativity of *magnitude* as is the point of view of Galileo and Newton with that of the relativity of motion. A wider principle is, according to Weyl, required, if the phenomena of the electro-magnetic field are to be accounted for and full harmony with Maxwell's conceptions is to be attained. And the wider principle, if it is introduced, means the modification of Einstein's laws and the recognition of a newly conceived world-curvature determining the very foundation of metric relations. A further form of tensor expression must follow.

One is reminded, in reading Weyl's description of these new possibilities, of the famous conclusion of

Riemann's essay on the hypotheses which lie at the foundations of geometry in which he says that if the actual reality underlying space is not a discrete manifold, the ground of the relations in its measurement must be sought in binding forces for the demonstration of which we must look to a science other than that of geometry—physics. These words, says Weyl, in a passage which is interesting to us over here, fell on the ears that were deaf to them of Riemann's contemporaries, deaf men all excepting one. And that one, he says, was W. K. Clifford.

But a doubt arises in the minds of those who are concerned with philosophy, which always has to look at things as a whole. The school of Einstein has told us that it is in Einstein's explanation of the gravitational field, as a set of forms produced by the movement of the observer in varying courses relatively to the bodies observed, that the origin and meaning of that field are to be found. But it does not seem so apparent that the variations in the characters of magnitudes to which Weyl has directed attention can be explained by any such principle of mere general relativity to situation in observation. Weyl appears to say that the explanation of variation in magnitude or gauge must be sought in some objective quality of reality independent of the observer, for otherwise the electro-magnetic laws cannot be accounted for. But if so the phenomena of the electro-magnetic field contain features which relativity to the observer alone, such as Einstein holds to be sufficient, apparently cannot account for. How are the two principles of variation to be combined into one? They are not the same, and they belong to different aspects of experience. What is the true character of the real accord-

ing to Weyl? Relativity to knowledge appears to be insufficient to explain his new qualities of invariance. For these seem to belong absolutely to reality itself and not to depend on our knowledge of it, as in the case of the Einstein principle of gravitation. This is a point which we who are mere philosophers would like the mathematical physicists to clear up for us. I shall presently call attention to the way in which this point has been discussed. It is suggested by more than one recent writer that not only Weyl but Riemann himself have created difficulties by tacitly assuming that concepts do not enter into the reality which is foundational of the phenomenal world of relativity itself, and have been looking for self-subsisting entities, disguised by being called 'invariants,' instead of for laws.

The attention of the few German mathematicians who are also trained in logic and metaphysics is being directed to the subject. Cassirer has approached the general problem in his recently published book, *Zur Einsteinschen Relativitäts-theorie.* His purpose is to bring the work of philosophy and mathematical physics into harmony. The results of the latter cannot claim finality. For they develop, he says, no more than the significance which space and time possess in our empirical and physical measurements. That significance the physicist may progressively vary. It is for the theory of knowledge to interpret, from a fuller point of view but equally progressively, the significance from time to time thus brought to light, and this interpretation may reveal a good deal of that undetected 'anthropomorphism' against which Goethe long ago warned men of science. "The symbols" (at p. 127 of the book) "which are made

foundational by the mathematician and the physicist in their outlook on externality, and by the psychologist in his view of the inner world, must be interpreted as being merely symbols. So long as this interpretation is not clearly made the true philosophical insight, that into the character of the entirety as such, is not attained, but a merely partial experience is hypostatised into that of a whole. From the standpoint of mathematical physics the entire content of immediate qualities, not merely differences in sense perception, but the qualities of our consciousness of space and time, threatens to tumble into fragments. For the metaphysical psychologist, on the other hand, all that is actual is to be sought in this immediacy, while all mediate knowledge through concepts has the value only of arbitrary convention, adopted to serve practical purposes."

Cassirer, who is an accomplished mathematician, thinks that there is a real gap between the views of space and time held by Kant and those of Einstein. For the doctrine of the latter these are always empirical and not pure transcendental forms. Even if, with Einstein, we grasp characters in them which are invariant in the face of all possible transformations, these characters are independent of the results of concrete measurements and particular conditions. They must be, therefore, conceptual and not intuitive. While the object in perception is not for the Critical Philosophy any absolute picture with which we can compare our ideas, but a 'conception in relation to which our ideas have synthetic unity,' for Einstein the real object is no picture at all, but a physical interpretation of one, assuming the form of equations the systems of which are covariant through all

arbitrary transformations. The relativity which thus arises is itself of a purely logical and mathematical nature. The object of physics is indeed a phenomenal object, but it no longer depends on any subjective contribution. Kant's standpoint is, therefore, insufficient for the doctrine of relativity and does not harmonise with it.

Cassirer goes to the real root of the question of the objective significance of the conceptions used by mathematicians when they speak about the character of experience in space and time as rendered in shape and measurement. Such experience the mathematician interprets exclusively under his own system of abstractions, which brings out its real character from his own standpoint.[1] Mathematical physics knows no limit in this recognition. It must follow its path unbrokenly; it dare not halt in its task of finding the general conceptions that for itself are true in the object which it has before it. Its duty is to render what can be counted into pure number, quality into quantity, particular form into general scheme of order, and by means of this process to comprehend. Philosophy would strive in vain were it to seek to arrest the process at any particular point in it. Its task is rather to indicate that, while it recognises fully the significance of the mathematico-physical conception of the object, it recognises it as a logically limited conception, limited by the standpoint employed. For as soon as we pass from the domain of physics we alter not merely the means but the aim of knowledge, and give it a new character. Logical structure and æsthetic consciousness may be quite different in nature and yet not in conflict. There is

[1] *Zur Einsteinschen Relativitäts-theorie*, p. 121.

a divergence not of entities but of standpoints. There has been a change in the sort of meaning. There is in each sort more than mere passive awareness discloses. Concepts of different kinds go to the constitution of reality of different kinds, and the orders in reflection must be recognised as distinct and must not be confused.

This view of the character of reality is at least akin to that discussed in *The Reign of Relativity*, and in the earlier portion of the present volume. The interpretation of the concreteness of individuality, and of the part played in its constitution by universals, is not materially different. Space is an example. Geometrical space depends on the assumption of the equivalence of all positions and directions, and their distinction from each other. While metrical Euclidean space is brought under the postulate of isotropy and homogeneity, the space of awareness through touch and sight is anisotropic and non-homogeneous. So it is with time also, and with the difference between what we mean when we speak of the continuity of awareness and that which we define by the constructive methods of mathematics in relation to number. Continuity in logic and in philosophy is thus something different from what is meant when the expression is used in the theory of number. A principle such as that of levels in knowledge and reality alike seems to present itself as the solution of such difficulties for Cassirer. He insists that the true objects of modern science are not entities, but laws. The confusion which is apt to arise comes from assumptions about the character of what is empirically 'given.' Our particular sensations are not in themselves the known and intelligible elements in know-

ledge. There are no absolute or self-contained sensations. Knowledge is no mere framing of 'pictures.' The true object is conceptual but none the less reality. The relativity theory ought not to seek to present it in mere pictorial form, but rather as a physical interpretation in the form of equations and systems of equations in which the altering substitutions are covariant. "The relativity which is thus brought about is of a purely logical and mathematical character. By means of it the object in physics is indeed determined as a phenomenal object, but to its phenomenal nature subjective arbitrariness and subjective contingency no longer pertain. For the ideality of the forms of knowledge and of their conditions on which physics as a science depends both guarantees and assigns a ground for the empirical reality of all that is meant when we speak of facts and their objective validity."[1] For example, the interposition between the ideas about empty space and about matter of the conception of the 'Field' since the days of Faraday and his 'Lines of Force' has taught us not to base the conception of matter on that of its field, but to regard matter as merely position in such a field. So also in electro-dynamics. So in the analyses of the intrinsic relations of measurement within the four-dimensional space-time world, the riddle of gravitation and of force acting at a distance is resolved and we are satisfied with the ten components of the gravitational potentials of the Einstein doctrine. In the form he has given them they serve equally what is required in definition of the metrical properties of four-dimensional space, and, on the other hand, for the expression of the properties

[1] *Zur Einsteinschen Relativitäts-theorie*, p. 57.

of the gravitational field. We obtain a unification of definite relations of *function* which vary in implication with the relative inertial systems in which we express them. Dynamics tends to become more and more a purely metrical system, but a system in which the conception of metric has obtained a generalisation and extension of a new kind, inasmuch as the metrical relations of Euclidean geometry become only a special case in a system which is far wider in scope.

Throughout his book Cassirer has gentle words of caution for mathematicians who talk as though their symbolic descriptions of the encounters of world-points were actual pictorial descriptions. He brings out the magnitude of the services which will be required from those trained in mathematical logic before we cease to suffer from obscurity and confusion arising from the unrestrained use of merely figurative language. "When, for example," he says at p. 85, "in the mathematical foundation of the relativity theory the formula is given for the 'interval' between two infinitely neighbouring points, x_1, x_2, x_3, x_4, and $x_1 + dx_1$, $x_2 + dx_2$, $x_3 + dx_3$, $x_4 + dx_4$, this must certainly not be thought of in the ordinary way as a rigid Euclidean line, inasmuch as by introducing time as a fourth dimension we are dealing, not with a magnitude of space, but with one of motion. Yet the foundational form of co-existence and succession, and of their mutual relation and union, is unmistakably present in this expression of the general line element. Not, however, because the theory here, as people at one time thought, presupposes space and time as already given—from the imputation of such circular reasoning it is absolved—but in the sense

that it cannot dispense with the spatial and temporal form and function in general." The history of physics, he says, is the history not of the discovery of a simple series of facts, but of the discovery of ever fresh special methods of thought. Modern science knows that a definite spatial and temporal order of phenomena only exists for knowledge in so far as knowledge is progressively bringing such an order into being, and that the only method of bringing it into being is through the work of science in thinking out laws. But the task, from such a point of view, remains a permanent one for reflection, and becomes for it sharper and more severe the more reflection makes us conscious that a final solution is never possible. Just because the unity of space and time seems ever to flee from empirical apprehension and empirical measurements, in reflection we realise that we must always persist in seeking that unity and must make use for the purpose of ever sharper and more novel instruments. It is the merit of the relativity theory that it has adopted no new way of doing this, but not the less, by employing the fundamental principle of the covariance of the universal laws of nature throughout all arbitrary substitutions, has established a principle by means of which reflection can direct the idea of relativity which it has evolved from itself.

Thus for Cassirer the renunciation of this idea that the world of so-called direct perception is of a character that is simple and obvious is at the same time the guarantee that it includes a more important self-containedness both for thought and in its own system. Space, to take an example, has its real ground, not in something existing apart from and independent of it, but as the ideal basis which discloses itself in the

progress and building up of a knowledge of what is real. He criticises Riemann's famous question as to the 'binding forces' which may be required for the explanation of its laws. Rather, he says, we ought to give up the idea of space as something existing in itself, to be explained like other realities that are the outcome of binding forces, and to ask whether that *a priori* function, that general ideal relation, which we name as space, does not contain in itself various possible forms, and among them those whose part it is to yield an exact and exhaustive presentation of definite physical relations and definite fields of energy. The development, he adds, of the general theory of relativity has answered this question in the affirmative; it has shown that which for Riemann was a geometrical hypothesis, a mere possibility for reflection, to be an actual mode of our knowledge of the actual. The Newtonian dynamics have become kinematics and the kinematics have been resolved into geometry. Only, by taking a step further in the region of empirical knowledge, we have widened the content of geometry and have substituted one more complex for the simple Euclidean type of geometrical axioms. We have thereby acquired fresh means for bringing to light the relations in the real and the structure of what is empirical but manifold. We have to look on the pure space-time manifold as the logical prius, not as if it were in any sense heralded and given as an entity outside and antecedent to physical experience, but as forming the principle and fundamental condition of all empirical knowledge of physical relations. For example, when the notion of the special three-dimensional manifold that has a constant measure of curvature, *o*, is

enlarged into the notion of a system of manifolds with different constant or variable curvatures, we are provided with new conceptual symbols which express not things but the possible relations which result from their laws. Minkowski's 'postulate of an absolute world' resolves itself in the end into the postulate of an absolute method. "The general relativity of all positions, times, and measuring instruments must be the final word of physics, because the reduction to relativity, the resolution of the object of nature into pure relations of measurement, forms the kernel of procedure in physics, inasmuch as it is the fundamental function of physical knowledge." But Cassirer guards himself at this point. It is true that the mathematical method can recognise no barrier in the path of its own procedure. It can convert the value of time into an imaginary quantity, as Minkowski showed, whereby all actuality and all the qualitative difference which time as a form of inner sense seems to possess appear to become annihilated or inverted. Philosophy is quite aware of this. Its duty is not to contradict the claim of what is the method only of a standpoint, but to point out the limitations of the sphere of the knowledge to be got from it. The limitation of this knowledge is inherent in that of its standpoint and its method. There are other standpoints and methods which yield the actual in a form which mathematical reasoning does not touch. Differences in meaning fashion different kinds of reality. Speculations about the experiences which those would have who made journeys with the velocity of light require careful recognition of the limits of the domain within which the methods of mathematical physics are confined by its standpoint.

In another recently published book, *Relativitätstheorie und Erkenntniss a priori*, an equally well-furnished writer, Hans Reichenbach, goes further. It is for him the mistake of Kant to have made pronouncements about the subjective elements in physics which had not been brought to the test of experience. It is only now, when experience has established in physics the relativity of co-ordinates, that we can treat the ideality of space and time as demonstrated. If Weyl is right a new *conceptual* element has been discovered in metrics, a form of description analogous to that arising out of the situation in which we find ourselves with co-ordinates. The concept of the object has changed, and with it the estimate of the part knowledge has taken in the constitution of our perceptions. This may alter progressively, and affords the ground on which we must conclude that the formulation of the nature of direct knowledge cannot be given in such unrestricted pronouncements as that space is merely ideal, but only in the enunciation of mathematical principles. The procedure of eliminating by means of formulas of transformation the subjective aspect in description out of objective significance therefore takes the place of the Kantian analysis of the part played by reason. The Kantian table of categories becomes primitive in comparison with the modern theory of invariance.

In Reichenbach's view, since all the results of direct experience are only approximations, it is quite admissible to regard them, collectively and as the outcome of induction, as exhibiting a more general principle. It is both logically and technically possible to ascertain inductively new principles of order which exhibit a continuous enlargement of those

hitherto employed. We may call such generalisation continuous inasmuch as the new principle passes for approximately realised cases into the old one. Kant's mistake was to analyse perception as if he could get at its nature by analysing reason. He thus really sought after axioms instead of categories. No doubt perception is determined by reason, but the character of this influence of reason is expressed only in perception. Reason is no system of final principles, but a faculty which becomes fruitful only in its application to concrete cases. Kant's standpoint was limited by its conventionality. The object for reason does not stand still. It is the merit of the relativity principle that it has transferred the question of the validity of geometry from pure mathematics to physical experience. Reichenbach takes exception to Weyl's criticism of Einstein referred to earlier. It is not necessary, he says, to give up altogether the notion of an unvarying length for an indefinitely small measuring-rod. It may be that Weyl's view of the more elastic and general character of such a rod is a possible one, but whether it is so depends not on considerations of infinitesimal geometry but on what experience discloses. Physical results do not depend on geometrical necessity. Rather do our notions of our object in science, of reality and of its characters, depend on gradual and progressive precision in interpretation. The part played by reason is, not to offer unalterable elements in an ordered system, but to make provision for apparently arbitrary elements disclosing themselves within its system. The conception of the object in knowledge can thus be alterable and progressive, in accordance with the development of principles in an ordered system. That the real in

physical science can be described in terms of the metrical relations of four co-ordinates is as certain as the validity of physical science itself taken as a whole. It is only the special form assumed that is the problem of empirical research. Still, there may come a time when we shall have to enlarge our principles and our conception of the physical object, as the result of further experiment; only such enlargement will proceed on a basis of continuity. *A priori* may mean antecedent to direct knowledge, but not for all time or independently of experience. We fall, moreover, into a mistake when we suppose that our metric gives us geometrical images, instead of those that indicate a merely physical condition. What ties us so tight to the employment of Euclidean geometry is that we think we come by it to pictures of actual things. But as soon as we see that knowledge is here something quite different from the display of resembling shapes, and that the real metrical relation has a different meaning, we are prepared to give up the instinctive tendency to look on Euclidean geometry as a necessary form of reality. It is this confusion between the two kinds of image that makes it difficult for the untrained mind to accept Riemann's geometry. It is no assertion of the doctrine of relativity that what was formerly the Euclidean picture is now a picture of something curved. What is really asserted is that there is no such subjectivity, and that what is expressed in metrical relations is something other than a repetition in images of objects. We can indeed form geometrical pictures, but they may not suffice for the characterisation of empirical facts. It is not that such pictures are in themselves false, but that they may not be applicable to the actual facts.

The task of the theory of knowledge is to explain the nature of knowledge by analysing the content of experience, without reference to artificial images and analogies.

What is most interesting in the criticism of Kant by Cassirer and Reichenbach is that it is directed against the attempt of the Critical Philosophy to break up the unity of the object in experience, and thereby knowledge itself. The conclusions of these two writers, if they do not explicitly assert the conceptual character of the actual which Aristotle and Plotinus contended for long ago, and which the objective idealists of the last century finally came to, are much more in harmony with it than is that teaching of Kant which they criticise.

It may well be that, notwithstanding the claims put forward on his behalf by enthusiastic disciples, but never, so far as I know, by himself, Einstein has not come in sight of the 'binding laws' which Riemann thought might be discovered as lying at the foundation of the spatial relations manifested in experience, and that it would be superfluous for him, as a mathematical physicist, to search for them. It may equally well be that such an investigation as Einstein has so far made into the differences between what is only relative in space and its invariant characteristics is no final one. Experience may compel an enlargement of Einstein's conceptions, taking account of more than the effect of the presence of a gravitational field, and including characteristics lying beyond any subjectivity of the kind to which Weyl takes exception. The interpretation of the actual may have to be enlarged, and perhaps in the end again and again enlarged; for our knowledge, conditioned as

it is, never can attain finality in the interpretation of what must seem to confront us as if independent. But the distinctions, here as elsewhere, all fall within knowledge and are its creatures. That is why our human knowledge is always in the nature of progressive interpretation of the given, and that is why the general theory of relativity may have to be extended so as to provide for the admission of suggested novel constants. But this will not have been, if it turns out so, merely because of some new self-contained fact which confronts us. It will happen because there is no such finality in the concepts or systems of universals we employ as prevents us from developing them without breach of continuity into ideas which make practicable in the interpretation of what is actual a larger outlook and a deeper insight.

CHAPTER VII

BIOLOGY

THIRTY-EIGHT years ago, I wrote, in conjunction with my brother, now Professor J. S. Haldane, an "Essay on the Relation of Philosophy to Science."[1] We were both interested at the time in the theory of knowledge, to which that Essay was devoted. Since those days he has continued work at problems in physiology, while I have been occupied with other subjects. Nevertheless I have not ceased to follow his investigations with keen interest. Some of their early forms are described in the Essay to which I have alluded. Other inquiries of a still more searching character have been developed by him in the course of the years which have elapsed between 1883 and to-day. The results have been recorded in a succession of books and papers on which I have drawn freely in what follows. His *Mechanism, Life, and Personality* was first published in 1913. A new edition appeared in 1921. *Organism and Environment* was published in 1917, and *The New Physiology* in 1919. A further volume by him on *Respiration and the Physiology of Breathing* is passing through the press while I write.

As I have said he is a physiologist, immersed in laboratory investigation, and I am not. But a good deal of reading and discussion has tended to strengthen

[1] Published in a volume called *Essays in Philosophical Criticism*, by various authors. (Longmans, 1883.)

the view, first formed more than thirty-eight years ago, of theory and practice alike as disclosing that life can only be interpreted and rendered in terms of life. The understanding of this fact; if it be one, is vital for philosophy itself. Approaching the conceptions of biology from different standpoints and with minds differently trained, my brother and I, in the old Essay to which I have referred, had come to the conclusion that in observing and recording the behaviour of living organisms conceptions are freely used which belong to an order in knowledge different in character from that to which the conceptions of mechanical science belong. "It is not the case," we wrote in those days, "that the fittest survive after the fashion in which the roundest shot only reach the bottom of the sloping board used by shot-makers to eliminate those that are imperfect. Development is in all cases the realisation of what was not there at the beginning of the process. Yet the resulting difference is not conceived as impressed from without, but as freely produced from within itself by that which develops. A little consideration shows that such branches of biological science and morphology become possible only through the conception of development." Further on, referring to morphological identity, we said: "If there were no point of view higher than that of mechanism, such conceptions as those which have now been briefly examined would be meaningless. But it is just because there is such a point of view, possibly by reason of the fact that the phenomena which it embraces are constituted through higher categories than those of spatial and temporal arrangement, that as science advances men are driven back to the use

of these higher conceptions in spite of their attempts to dispense with them. For such attempts lose their meaning as soon as it is recognised that to abandon them in no sense implies the admission of an exception to the uniformity of nature. The man who insists on regarding organisation and development as mechanical and the man who insists on the existence of supra-mechanical substances and causes, are alike dogmatists, whose principles are really untrue to those facts of common sense with which science and philosophy alike must start. If, then, a critical examination of categories can reconcile the truth which lies at the bottom of each point of view, and, without for a moment seeking to intrude into the domain of observation and experiment, yet throw light on conceptions which are necessarily used in obtaining and arranging the results so reached, surely such a criticism becomes a matter of the last importance." And a little later: "It is no doubt quite correct to lay stress upon the mathematico-physical relations of matter, and to reason from them in an abstract reference. But even such appropriate abstractions, when hypostatised in thought into real existences, share the general fate of all other abstractions, and give rise to contradictory conclusions. We can no more consistently represent to ourselves matter as constituted by the reciprocal determination of points of attraction and repulsion in space, than we can conceive matter and energy as independent existences. Such abstract conceptions, however great their value as regulative, i.e. for the purpose of advance in knowledge, are not adequate as descriptions of a reality which is essentially concrete and inexhaustible in its properties. . . ." "The history of the past

relations of science and philosophy has shown that so long as the spheres of inquiry remain in different hands—in the hands of persons who are more or less ignorant of each other's subjects—so long will science have cause to reject many of the inferences of philosophy as the intrusion into her domain of something akin to *a priori* reasoning. But it is no less true that under these conditions the philosopher must have equal cause to complain of the man of science, in that he perpetually raises difficulties insoluble for himself in his own department by the dogmatic application of mistaken categories."

It is not without interest to compare with this something said in the recent book by Professor Cassirer already quoted. I translate a passage in which he is dealing with what is in appearance a different subject, Newton's principle of inertia.[1]

"The difficulty, however, which remains in the structure of classical mechanics for the formulation of the principle of inertia, lies in the circular reasoning out of which there seems to be no way of escape. In order to make intelligible the meaning of the principle we make use of the notion of 'equal times.' But a useful physical measure of equal times we can only obtain, on the other hand, if we assume the law of inertia, in both its content and its validity, to be already there. In point of fact mechanics has sought—since Carl Neumann's well-known memoir on *the Principles of the Theory of Galileo and Newton*, which first set going the modern discussion of the law of inertia—to define 'equal times' as those within which a body left to itself traverses equal distances. Maxwell also, in his account of the Newtonian me-

[1] Page 22.

chanics, treats the law of inertia as a pure definition of measurement. Newton's first law—he declares in precise language—tells us under what conditions there is present no external force ('Matter and Motion'). In the development of mechanics the law of inertia is even more definitely recognised as substantially what it signified for Galileo. It stands good to-day no longer as a direct empirical description of given processes in nature, but as that regulative axiom, that fundamental hypothesis, by means of which the new science of dynamics ascribes a definite form to measurement. Inertia appears no longer as an absolute and inherent property of things and of objects, but as the free determination of a definite measuring rod and symbol of measurement, by means of which alone we can hope to attain to a collective and systematic interpretation of the laws of motion. Herein only lies the root of its reality, of its objective and physical meaning. Thus here also, within the historical development of physics itself, measuring divides itself more and more clearly from what is measured, that with which at first it seemed to coalesce. And so there are dividing themselves more and more clearly the observable data of experience from what must be presupposed and used as the condition of observation and measurement."

In the preceding chapter I drew attention to the fashion in which concepts and laws enter into physical reality and mould it. The conceptual character of the actual follows from the general principle of the relativity of reality to knowledge, and on this point Cassirer and Reichenbach, with regard to physical science, appear to present a view in harmony with that given of biological science in the Essay of 1883

which I have already quoted. In this chapter I propose to follow the principle into illustrations from experience. But just as my personal knowledge in the case of physics has been mainly derived from the study of books and only to a small extent gained in the laboratory, so in the instance of biology I have drawn mainly and freely on the results worked out and recorded by my brother and by others during long years of practical as well as theoretical investigation.

The business of philosophy is to inquire into the character of the various standpoints which combine in the constitution of experience, and to ascertain the differences in the aspects of reality which its relativity to these standpoints brings about. The results of metaphysical inquiry under the various systems which make up its history are not, as was pointed out in some detail in *The Reign of Relativity*, so inconsistent as is popularly believed. The question in each case has been in the main one of emphasis or stress laid. There has been concentration on aspects that have varied with the tendencies of the period. We find the same thing in literature and in branches of knowledge that do not depend on quantitative measurement. Even when this last is prominent modern science, as we saw in the preceding chapter, has progressively given to quantitative measurement a conceptual significance. It is no longer practicable to dissociate intelligently any one branch of knowledge from a place within the entirety of knowledge. For this proposition the Relativity physics of our time affords the most recent evidence. In the case of biology the task of philosophy is therefore analogous to its task in the case of physics. It has to ascertain

and scrutinise the conceptions which give meaning and so actuality to its subject-matter, life, and in which life presents itself as a phenomenon.

Although life is *prima facie* very unlike the mechanism considered in physics it is none the less conceptual, in the sense that what Cassirer in the case of physics calls "laws," or what I have called meanings or interpretations, are what give it objective existence. The determining quality of that existence may be most easily seen by contrasting the laws that obtain in the domain of life with those of physics. In the latter we start with a causal relation of succession, in which the cause is taken as something separate from the effect. As knowledge progresses we reduce the relation to one of succession, as Einstein has done in the case of gravitation, and as has been accomplished by the reduction of matter and energy to phenomena of position and change in the "field." It is the uniformities or laws that obtain in the field that give objectivity to its contents, and these operate, from the point of view of the physicist who has to treat them abstractly, by way of succession according to principles.

But when we turn to life we find ourselves confronted with phenomena which are of a character quite different. They are what they are only from a standpoint at which conceptions diverse in logical character from those of mathematics and physics appear in them. It is no more mere causation or mere succession of events that we have before us. These we can and do impute to the new phenomena when we regard them abstractly or partially from a special standpoint which is not the obvious one. But if we take in the determining character of what

we observe we notice in it something quite different from the governance *ab extra* of physical science. Living organisms *behave.* They behave in fulfilling what need not be and generally are not, so far as observation teaches, conscious purposes. But the details of both their structure and their activities exhibit maintenance of something which we cannot help recognising and which we call the *life* of the organism. In so far as its life dominates the phenomena in connection with an organism these phenomena are determined from within and not from without. The life of an organism has the character of a whole which has no existence save in its parts. But, excepting as belonging to its proper whole, the part on the other hand does not *live.* Its structure and activities are totally altered when it is removed from its place and function in that whole. Its end as a subordinate whole is to be an organ of the bodily whole and it is the fulfilment of this end that does not merely *give* it but *is* its life. In living the organ behaves in fulfilment of this end, but the end is not antecedent in time to the organ, the behaviour of which it controls, as is a cause to its effect. It is actual only in the behaviour in which it expresses itself. It acts presently and not before or after the event, although its operation may endure through a tract of time and result in a developing course of change. It is a universal which is real through the particulars to which it gives meaning in constituting the individual in which it and these become actual. That individual may itself be determined by what bears some analogy to the field in physics, the species to which the individual belongs. But it is the fulfilment of the end of which life is the expression that characterises and is

constitutive of the species, and is in that relation determinative of the individual members, along with their conduct and course of life. Nowhere does the relation of life present itself as one of cause external to effect. In every case we seem to see behaviour in fulfilment of immediately present and inherent ends. Reality is disclosing itself in a fresh aspect, and the concepts to which it owes its meaning are the concepts of a standpoint wholly different from that of the mathematician who deals with order in externality and the physicist who is really concerned with the same relation.

Of course we may say with full truth that in the domain of life our knowledge extends to these other aspects also, and that apart from them the realm of life would be an abstraction. Physics and chemistry are required by the biologist in his investigation into the phenomena of the living organism. Without their help he could not solve physical problems which have to be solved, connected with quantity of energy taken in and given out, as well as with countless other problems. But the addition of the results got by such methods of knowledge appears to be wholly inadequate to the description of the characteristic phenomena of life. The physical and chemical methods yield valuable abstractions, but they do not solve the problem of the actual for the biologist, any more than they solve that of the artist or even the student of human nature.

In order to see how this appears so let us look at the characteristics of life. In the interpretation of the living organism we seem to find that the conceptions which force themselves on us in physics and chemistry, those of the relations of matter and energy

and of chemical structure and its changes, fall short of what is necessary for the expression of the facts. These physical and chemical conceptions are indeed, as we have already seen, not what an easy-going anthropomorphism has taken them to be. They are themselves interpretations which have been simplified by the criticism of the school of relativity. But even in a crude form they have been of the utmost value as working hypotheses, which have enabled us up to a certain point, but up to a certain point only, to express and to predict phenomena. They belong to knowledge in one of its many aspects, and their limitations appear to be due to insufficiency in the standpoint from which we bifurcate our world into knowledge and its objects. No doubt, as I have said, they are beginning to be modified. They have been affected by such new ideas as those of the relativity of shape and measurement, the resolution of mass into inertia, the electro-magnetic theory of energy, the discovery of the periodic law and its application in chemistry, the transmutation of chemical elements in connection with radio-activity, the light cast by Faraday's discovery that in electrolytic dissociation of matter the ions which result have definite electrical charges, and the still further light which the electron theory is throwing on the structure of the atom. Still, the old-fashioned conceptions have in their time proved valuable handmaids, and if they are now grown too infirm to do their old work we have still to be grateful for them. But in the region of life they have played only an auxiliary and not a leading part. Auxiliary, because they permitted us to take the living body, not as living structure, but as a thing self-contained and independent of its environment,

and, on this very dubious assumption, not borne out by observation, to apply exclusively the methods of the physicist and the chemist. No doubt much information of provisional value is to be got in this way. By adopting it, and treating the body as a heat-producing machine, Lavoisier gave the world a clear and useful working hypothesis. What it failed to take account of was that the heat-production was organically regulated. Moreover a further price has had to be paid for such a picture of life as mechanism. Anatomy and physiology, particularly anatomy, have been profoundly influenced by the *a priori* conception of the living structure as being inherently a mechanical structure. One result has been that medicine has found itself divorced in a large measure from sciences which ought to have been its foundation at every turn. When presently we come to the character of life we shall find it to lie in the preservation of what is normal with the organism. It has normal conditions up to which it maintains itself and so preserves its continued existence. In the maintenance of these normal conditions health consists. Such normals are for anatomy usually conceived as being no more than mere external structures, and for much current physiology as no more than mere averages. But are such relations not rather manifestations of the life of the organism regarded as a whole? The various functions, such as breathing, oxygenation, digestion, metabolism, combine to maintain life, and in this maintenance the structural activities of the various organs adapt themselves to what they perform. The whole determines the parts and subsists in their co-ordinated activities. Just as in society human beings try to live up to

normal standards of conduct, which keep their lives on a level with the lives of others, and strive to avoid getting into the bankruptcy or the police court, so the organism tends to maintain a continuously healthy life and to avoid deficiencies which may destroy that life.

The practical purpose of the physician is to restore or maintain health. What is health? It is what is biologically speaking normal, the condition in which the body is maintaining all its functions in an efficient state and as an entirety. What the doctor sees in the sick man is a perversion of his normal condition, and he watches the effort of nature to get rid of this perversion and tries to assist with medicines and nursing. He has to understand what the process means. If he knows how breathing is normally regulated he will distinguish between various reasons for abnormal breathing, and so in the cases of other symptoms. That will be because he is an experienced practitioner who has seen such things often and has dealt with them. For if he had to depend on knowledge of physics and chemistry merely, or even of anatomy and physiology as explained in textbooks which seek to exhibit them as illustrations of mechanical laws, he could not know adequately how he stood. His subject is not these things, but an organism that is alive. Scientific knowledge of mechanical and chemical laws is very valuable, but taken by itself it is not enough. That is why so many practical doctors hold these studies in lighter esteem than they should. The proper study of medicine requires them, but it requires knowledge of a physiology based on what health really means, and on how it can be maintained

under varying conditions of environment. It requires, too, a pathology which will teach how health tends to reassert itself under abnormal conditions, and a pharmacology which will teach, not merely the action of drugs in the abstract, but how they can be used, all the conditions being taken into account, with well-founded hope of assisting nature to re-establish normal conditions in the particular living organism.

We have seen how the laws of physics and the reality of phenomena for the physicist depend on the interpretations which are made from a definite standpoint and enter for us into their existence. So it is with biology. We have to determine our standpoint and its relation to other and different standpoints if we wish to get at that meaning of the data which makes them what they are both for us and in themselves. In physics the data are taken as external to and independent of each other. That is of the essence of the procedure of the mathematical physicist. His symbols take no cognisance of behaviour as exhibited in life or purposive action. But when we are observing a living organism this is just what we must take account of. We cannot get at the meaning or the reality of our data if we take them as if existing in isolation from each other. It is characteristic of the phenomena with which we are here concerned that the details of form, movement, and chemical composition which we distinguish in them are essentially and not accidentally connected with each other. "We are accustomed to the fact that a limb, or even a bone, of a certain build is associated with a whole body of a certain build. We know also that if an animal is breathing we may expect to find its heart beating and all its other organs

in a state of more or less evident activity. We associate together the details of structure and activity as those of a living animal; we think and speak of it as alive, and we regard its structure and activities as the expression or manifestation of its life. What I wish to maintain is that in so regarding a living organism we use an hypothesis which is for biology just as intelligible, just as elementary, just as true to the facts known, and just as good a scientific working hypothesis, as is the hypothesis of the indestructibility of matter for physics and chemistry."[1]

The ordinary physician who does not trouble himself with speculative questions and who is not the prey of "unconscious assumption" takes much this view of his patient. It is when we come to the domain of theory that controversy arises. If reality is really relative to standpoint in knowledge there is no more difficulty in accepting the facts as they seem to present themselves than there is for Einstein in accepting the velocity of light as a constant, the same for an observer at rest in relation to its source as for an observer in motion to or from that source. But for those who have not made their own the principle of the relativity of reality to knowledge throughout the sciences, an insuperable dilemma seems to them to present itself when they are asked, here as elsewhere, to believe in the reality of the world as it seems. They think that they must either reduce the phenomena with which they are confronted to interpretations which are purely mechanistic, or that they must admit the presence of some influence of which science can take no account consistently with the only principles which they admit. They hold

[1] *The New Physiology*, p. 31.

themselves forced to a choice between a consistently mechanistic view or one which admits a special vital principle as causally operative. We shall have to consider the first of these alternatives in some detail. Meantime it is enough to take one illustration as disclosing an initial difficulty in its way. If there is any feature that is clearly present in a living organism it is its capacity not only to maintain but to reproduce its own structure. But when we try to state such a process of reproduction in mechanical terms we have to state it as the necessary result of certain simple properties of simple parts which interact in the event. For a mechanical explanation the reacting parts must first be given. Unless an arrangement of parts with definite properties is given, it is meaningless to speak of mechanical explanation. If the matter is to be carried far enough the description must become one in the differential equations of mathematics. Now, as has been remarked in the volume I have just quoted[1]: "To postulate the existence of a self-producing or self-maintaining mechanism is thus to postulate something to which no meaning can be attached. Meaningless terms are sometimes used by physiologists; but there is none so absolutely meaningless as the expression 'mechanism of reproduction.' Any mechanism there may be in the parent organism is absent in the process of reproduction, and must reconstitute itself at each generation, since the parent organism is reproduced from a mere tiny speck of its own body. There can be no mechanism of reproduction. The idea of a mechanism which is constantly maintaining or reproducing its own structure is self-contradictory.

[1] At page 142.

A mechanism which reproduced itself would be a mechanism without parts, and therefore not a mechanism."

In a crystal we have a good example of apparent self-increase. If we lower the temperature of water to below the freezing-point without allowing it to freeze, and then throw into it a small crystal of ice, the fragment increases spontaneously and becomes a larger crystal. The molecules of water attract each other and fall into a physical arrangement in which by their disposition in space they occupy more space than before the water to which they belong is frozen. The crystal is also constantly giving off and taking up molecules of water from its environment. So far there is some semblance of analogy between the crystal and an organism. But the semblance breaks down. The arrangement of the molecules in the crystal is a mere repetition, but in the organism there is individual variety of detail controlled by unity, not necessarily of detail but of plan. How this plan will accomplish itself we cannot predict on mathematical or physical principles. We are dealing with a living individual structure possessing properties which are highly complex and which vary in each case, not only with the structure itself but with the environment, minute differences in the character of which may affect profoundly the activity of the living structure which depends on that environment for its growth.

The mechanistic explanation encounters difficulties at every turn, of which that referred to is only an illustration. But the explanation offered by what is called 'vitalism' is confronted by difficulties which, if of another kind, are just as great. The theory of

vitalism is that ordinary physical and chemical explanations, useful and necessary as they are for the study of the living organism in certain of its aspects, do not account for its behaviour or the controlling influence which gives rise to its distinctive activities. These the vitalists therefore look for in a controlling power which is apparent only in life and which is quite different from any with which we become familiar in the inorganic world. In the autonomy of living organisms we have their essential quality and the record of their history. Such autonomy arises from a vital 'force' or 'principle' which is operative in bringing about their distinctive activities. The older vitalists apparently regarded this vital 'force' as being something superadded to mechanical action and arrangement, which, like the mechanists, they took to be characteristic of nature in its organic as well as its inorganic aspects. Of late, under the leadership of teachers like Driesch, they have substituted the expression 'entelechy' as a better description of the vital principle the controlling influence of which they hold to be manifest.

But such vitalism, even in the form which Driesch gives it, seems to prove either too little or too much. Too little, in so far as a large field in the behaviour of the living organism is left to be explained in mechanistic terms and through mechanistic conceptions. Too much, in that it is not possible to find a line of demarcation showing where the sphere of the one begins and that of the other ends. An entelechy or vital influence becomes itself a sort of mechanism in any view which places it alongside of and co-ordinate with the causes and effects which belong to mechanism. It is a world of externality in order to which we are

held bound, and such an order of externality is different in its very nature from that of which the level is one at which ends and the organs which express them are indistinguishable alike in space and time. The other way is to take the course which we adopt when we are concerned with ethics, with beauty, and with the religious consciousness. In these cases we do not look for different entities. What we contemplate is reality with a difference in meaning due to difference in standpoint, reality that in this way owes its very nature as a fact confronting us to its relativity to the kind of knowledge for which alone it is actual. Concepts of the nature of universals enter here into the constitution of individual facts, just as they do at the standpoint of the mathematical physics of relativity when the velocity of light is disclosed as a constant, or when an 'interval' in an underlying four-dimensional world is stripped by reflection of all quality of shape and measurement, and yet is not the less accepted as the 'invariant' foundation in all relations of externality. Such a view of things is no doubt an unfamiliar one to the man in the street, whose mind is encrusted with the only half-thought-out conventional assumptions which serve him best in the rough practice of everyday human intercourse. But they are not sufficient for science, nor even for the man in the street himself, and unless their relativity is recognised as bound up with standpoint in knowledge they exercise a distorting influence upon its conceptions. We are becoming more and more aware, as generation after generation makes further progress in exact thinking, how essential it is that we should always be on the alert for the misleading intrusions of merely con-

ventional assumptions, and should never leave out of sight the possibility that the categories we habitually employ may require criticism and revision. The true question is not why we should adopt a mechanistic or a vitalistic attitude in considering the phenomena which life displays. The real question is whether either one or the other is required. For if we are at liberty to look at the facts as the closest observation appears to disclose them, and just as they seem to present themselves, without twist towards one hypothesis or bias towards the other, then we may take the course that is natural in the interests alike of science and of common sense. If I am right in the general conclusions about the relation of reality to knowledge which I have already set forth, the history of philosophy teaches us, on a distinct balance of testimony, not only that we are free to do this, but that the course is the only one which we can legitimately take without imperilling the advance of knowledge generally. The facts of life will on this footing be facts which can be rendered only in terms of the concepts of life. These afford no warrant for the notion that we can reduce life to mechanism and so end to cause any more then they afford warrant for the notion of a vitalistic cause which is none the less a cause in that its effect is life. The level or degree in knowledge from which the facts present themselves when we apprehend what is living has its own conceptions, and these are the conceptions appropriate to the standpoint to which the knowledge of nature in its aspect as biological is relative. What we have to do is to look at the facts as they present themselves, and simply to observe what their implications are. If these indicate

the standpoint as one which is unmistakably appropriate, then the doctrine of the general character of knowledge and of its relativity tells us that the standpoint is one which we need not hesitate to accept.

When we observe life we are observing objective nature just as much as we observe mechanism when we examine the heavens with the telescope or the resolution of white light into its component colours with the spectroscope. Both modes of observation depend on interpretations which turn on standpoint in knowledge, but they are interpretations which enter into and fashion the actual, meanings which determine what is real. In studying the living body we do not separate off and specify occurrences as due to separate parts in the fashion we find them separated off and specified in a machine. In nervous responses and especially in conscious responses the whole nervous system and indirectly the whole organism with its environment are involved. The response is the response of the living body as an entirety, and not merely that of the brain or any other particular organ. It is their fulfilment of an organic unity, their contribution to the maintenance of the normal life of the organism, that makes inappropriate as an explanation the otherwise indefinable and inexhaustible complexity of what we are confronted with in the endeavour after interpretation as physical and chemical reactions. It is only their clinging to an *a priori* metaphysical view, held most often unconsciously, that makes so many try to render the phenomena of life into physical and chemical conceptions; a metaphysical view really no better than that at another extreme held by the interpreters in a different sense

of the phenomena of the liquefaction of the blood of some long-deceased saint. Perception involves activity of reflection in the selection of what is perceived and the abstractions which are made in the different forms of knowledge. The standpoints overlap, and it is by collecting the results arising from the employment of their respective conceptions that we constitute and arrange the various sciences. The idea of the physical world as one made up of self-existing matter and energy is the outcome of a useful and necessary working hypothesis. But not less useful and necessary is that of life as a phase of the actual that is independent of this hypothesis, and is of a character epistemologically distinct from it. The purpose in all science is to find order and intelligibility in its objects, and different standards of reference may be required by sciences which prove on that account to be of logically different characters. A plurality of standpoints may be required for the comprehension of an individual object, and the meanings sought for may have to belong to more orders than one. But the natures of these meanings have to be kept distinct in reflection. The biologist takes cognisance of physical and chemical changes as the sensuous data which he must ascertain in the course of interpreting them. It is by bringing the results into a larger whole that he arrives at physiological knowledge and sees behind changes in form, in electrical activity, in oxygen absorption, in the outward signs of muscular activity, the metabolic activity of living organisms. Life manifests itself both as structure and activity. But in each case the manifestation is of what is living. The structure expresses living activity, and the ceaseless metabolic

change of which visible structure is the outward expression is a phenomenon closely related to what we call nutrition. The changes in the retina when light falls on it are in part chemical, but they are not the less metabolic or structural activities. So are the activities of nerve cells, muscle cells, gland cells, or any other living cells. Even the greater visible movements of the body are but the outer signs of metabolic activity. In metabolism the food of the organism is converted into the products which the organism requires for the maintenance of its life. The processes are during health of exquisite regularity and delicacy, *quasi*-purposively directed so as to maintain life. Even in ordinary nutrition nothing remains still and inactive. Living structure is really alive and full of molecular activity, and expresses directions and velocities which this activity takes. Substances are constantly being taken up from and given back to the environment; and even when these substances do not seem to be used up in nutrition, as in the case of inorganic salts, there is a constant molecular interchange between the cell and its environment. Cell secretion, cell respiration, and cell nutrition seem to be only different forms in which molecular activity thus directed appears.

A good illustration of the great part played in life by metabolic activity is afforded by observation of the way in which the circulation of the blood is regulated. The blood brings to the tissues the various substances required for their normal life, and removes from them substances which are then carried to other tissues or to secretory organs. It also conveys heat. That it also carries oxygen and carbonic acid is another among its many functions. The flow of

blood through any part of the body depends partly on the difference in blood pressure between arteries and veins, and partly on the resistance to flow from the arteries through the capillaries to the veins. The blood pressure in the veins is lower than that in the arteries and varies because of variations in resistance due to the varying calibre of the small vessels. The stimuli which determine these variations appear to originate in accumulation of products of metabolism, or through deficiency of the substances required in it. In some way such as this it appears that the flow of the blood through the different parts of the body is regulated in accordance with the requirements of each part, so that during extra activity in any part there is a correspondingly greater blood flow. Greater oxygen consumption is accompanied by increased circulation, and so is increased production of carbonic acid in the venous blood. The pumping action of the heart, although the primary motor power, is not the regulator of the circulation of the blood. It is the state of contraction in the blood-vessels that governs the rate of circulation. We come back for ultimate explanation to the metabolic activity of the living body as a whole. The blood circulates at such a rate as is sufficient to keep its composition approximately constant at any part of the body, and the rate of flow seems to be greater or less at any part in proportion as the causes tending to disturb the composition of the blood are greater or less at that part. Among the chief of these causes is consumption of oxygen and liberation of carbonic acid. The circulation rate is largely determined by the latter processes, and varies, just as the breathing varies, in such a way as to keep the gas pressures

in each part of the body approximately constant. The phenomena illustrate what was said by Claude Bernard as long ago as 1878, when he declared that "all the vital mechanisms, varied as they are, have only one object, that of preserving constant the conditions of life in the internal environment."

Such a picture as this of the regulation by the living organism of the circulation of its blood is surely no picture of any mechanism. It is a picture of what belongs to a wholly different domain. Such a system of self-conservation can hardly more be represented in the equations or diagrams of mechanics or the reactions of chemistry than could the proceedings of a Parliament. The conceptions required for the definition and expression of what is happening belong to an order that is of a wholly different kind. When we remember that the organism that behaves thus was originally a speck of organic matter which grew up inheriting the modes of behaviour of its parents, and becoming one out of a countless number of other similar living beings all conducting themselves in the same fashion, the attempt at a mechanistic interpretation which depends on chance, and on rejecting end as distinguished from mechanical cause, becomes an apparently hopeless one. Nor would common sense have permitted it to be made had it not been for the superstition that all real knowledge and all reality must be reducible to one order, and that the most abstract. For a theory of knowledge which discovers the actual only in what is concrete and individual, and which therefore finds itself compelled to explain from above downwards, and not from what is most abstract upwards to what is less so, the apparent difficulty

which throughout the history of reflection has stimulated the mechanistic attempt, is a difficulty which is really non-existent, inasmuch as it arises from a misconception.

Hardly less remarkable than the organisation for circulation of the blood are the arrangements by which it is kept supplied with oxgyen and carbonic acid. These last appear to be equally unintelligible from a standpoint confined to mechanical arrangements. It has been found that the breathing, which is governed by a special centre in the brain, reacts with almost incredible delicacy to minute changes in the reaction of the blood. It controls the reaction by regulating the amount of carbonic acid in the blood, which of course varies according as the breathing increases or diminishes.

That the respiratory centre should respond in the exact fashion it evidently does to change in the reaction of the blood is in itself extraordinary, but what is not less extraordinary is the fact that in the arterial blood the amount of carbonic acid remains during rest almost completely steady. Various kinds of acid-forming and alkali-forming substances are constantly being introduced with great frequency into the body by the food. And yet the reaction of the blood hardly varies at all under normal conditions, even when tested by the exquisitely sensitive indicator of the percentage of carbonic acid in the air of the lungs. It is indeed important that this should be so, for the indications are that disturbances more minute than those which are ordinarily measured in chemical tests may make a prodigious difference to physiological processes.

What regulates the reaction or the hydrogen-ion

concentration of the blood? It is now known that the most important agent is the action of the kidneys. It was for long common knowledge that the urine varies in acidity or alkalinity according to the diet. What was not known until it was recently discovered is that under ordinary conditions the variations in hydrogen-ion concentration of the urine are enormously greater than those of the arterial blood.

This astounding fact seems to be due to the responsiveness of the epithelial cells in the kidney. These answer so precisely to the demands arising from variations in the hydrogen-ion concentration in the blood that the very smallest variation in this concentration, in the acid or alkaline direction, stimulates them to excrete in the urine what is acid or alkaline with an intensity which is far in excess of any proportion to the state of the blood at the moment, bringing about the result that the condition of the blood in this respect is kept practically constant.

There appears to be good reason to believe that in the case of other features in the blood, such as the salts and amount of water in it, a similar *quasi*-purposive regulation is exercised by the kidneys. The delicacy with which they discharge this kind of function, in such a way as to preserve the normals required for the circulation of blood of the proper kind by the organism, is of a character that would appear miraculous were it only explicable by the physicist or the chemist as taking place apart from the phenomena that pertain to the order of life. The gland cells of the kidneys eliminate urea, for example, with such thoroughness that there is present as the

result in a given volume of urine usually about ten or fifteen times as much of urea as in the same volume of the blood. When the kidneys secrete sugar there may be as much as twenty or thirty times more sugar in the urine than there is on the average in the blood which they purify from it. When the kidneys excrete with this remarkable power it is because the concentration of the substance excreted is above what the normal conditions of the blood permits. Not only is the normal maintained there, but if the concentration in the blood falls for any reason below it the kidneys cease to excrete the substance. The capacity to do this work may be, of course, interfered with by pathological conditions. Minute doses of certain poisons or the want of oxygen may disturb it, and it may be heightened by the administration of drugs.

It has been found, too, that if a large quantity of water is drunk, the water which becomes present in the blood in an undue amount is excreted into the bladder without there being passed with it from the kidneys the ordinary normal constituents of the blood. However we look at the matter, what we find in the case of the kidneys is the same kind of regulation for preservation of the normals of the living body that has been referred to in connection with other organs. Whether it be breathing or circulation or the activities of the structures which form the liver or the kidneys the same type of phenomenon presents itself. We can neither perceive the actual living object excepting as manifesting the character that is distinctive of life, nor can we describe it in any terms belonging to an order more abstract than that which life forces on our recognition.

It is only the difference between life and the usual balancing of mechanical arrangements that enables the subordination of the processes of life in the fulfilment of the end of conserving it to preserve life through continuous change of material. The moulding influence of the whole is a normally unbroken and self-sustaining one which, within limits, is capable of adapting the environment and incorporating it. But the preservation of life depends on conditions so intricate and so delicate that a very small departure from such as cannot be controlled may bring it irrevocably to an end.

The illustrations just given show how different a living body is from a machine, an aggregate of parts which can be dissociated and afterwards put together again. The unity of the organism is wholly unlike this. It consists in its activity in maintaining its structure and activities right through a life history. We have given no adequate account of its character when we call it an aggregate of material. For it is much more, and is different in nature from such an aggregate. It is in a constant state of change—of taking in and of giving out its material, and of transforming it with exquisite and *quasi*-purposive delicacy. Not only molecules but living cells are being taken in, given off, and developed afresh. Between the organism and its environment no other line of real demarcation can be drawn excepting one referred to the ambit of the power of life itself, as forming what is distinctive of the individual organisms, in the exercise of control. Do the blood and the lymph belong to the organism or to its environment? A merely mechanical answer cannot be given. So of the gas in the lungs and the food in the intestines.

It is the normal activity of structure that affords the only solution. What we have before us seems to possess a kind of unity which we cannot explain or even describe in terms other than its own. It is a unity that persists through change in material which after a time has become complete. The conceptions that are appropriate to this unity, and to such a unity exclusively, are as distinctive as those which are characteristic in physics or chemistry. And they belong in both cases to reality as much as to knowledge.

The more we consider the results which the work of physiologists is placing on record in an always increasing degree, the further does merely mechanistic explanation seem to recede, and the more cogent does the evidence seem that the organs of the body exercise their respective functions in the economy of the whole more like human beings acting together in a society than like the parts of a machine. Human beings they do not really resemble, because their action is apparently not conscious, and is only *quasi*-purposively directed. The old idea was that phenomena of this nature might be explained as due to some sort of intra-cellular mechanism. But by degrees the extraordinary proportioning to the needs of the entire organism with which the organs discharge their tasks, and the fashion in which they adapt that discharge from time to time to conditions that are constantly varying, produced a sense that the problem was not so simple a problem as it had been taken to be. The old methods of investigation proved incapable of attaining their aim.

When we turn to what biological science tells us of pathology we have suggested to us not less strongly that in illness, as in health, the standpoint for inter-

pretation must not be other than that of life itself. In a fever there may be a higher temperature than what is normal. But this does not signify for the experienced physician that his business is to look out for some purely chemical source of production of heat within the fevered body. The rise of temperature depends on disturbance of the power of regulating body temperature, and usually signifies that the body has been attacked by an army of hostile microzoa which the forces of healthy nature are contending with and seeking to destroy. When a cold in the head extends downwards into the bronchial tubes we interpret it as meaning that some invasion of this kind has taken place, an invasion which the forces of nature may not be strong enough in some people or at some ages to contend against. The physician may think it necessary to inoculate in order to render such an invasion more difficult. When he does so he is opposing life to life, and not mechanism to mechanism.

Take again the case of the alarming disturbance of function known as diabetes. This disease depends essentially on a failure in self-regulation in the interests of the whole by living organs. Carbohydrates like fruit and bread and potatoes are a very important form of food, containing as they do sugar and starch. All the more complex forms of carbohydrate have to be converted into sugars, such as glucose and lævulose, before they can be utilised in the body. The process takes place in the alimentary canal under the influence of various ferments. When the sugar assimilated has got through the wall of the bowel it is carried by the portal vein to the liver, which converts about half of it into glycogen and stores it

up. The remainder goes into the blood and is eventually taken up by the muscles. The process of assimilation and storing requires the presence of a sufficient quantity of the internal secretion of the pancreas, and "the supply of what is termed the necessary hormone may be influenced by the state of the pancreas itself, by changes in other ductless glands which aid or oppose the pancreas, and also by certain nervous impulses." I take this description from the account of the pathology of the metabolic process involved given in an article in *The Edinburgh Medical Journal* for November 1921, written jointly by Dr. Murray Lyon, Lecturer in Clinical Medicine at Edinburgh University, and by Dr. Meakins, the Professor of Therapeutics there. The blood, this article goes on to tell us, normally contains a small quantity of glucose which in the fasting state averages 0·1 per cent. This circulating sugar is drawn upon during muscular activity, and more glucose is liberated from the liver to replace the loss. An increase in the amount of sugar present in the blood occurs in certain emotional states, such as fear or anger or great excitement. This is due to the action of certain nerve centres. In other cases where the increase of sugar in the blood is due to diet, the authors say that the rate of absorption of glucose from the intestine has become faster than the rate of assimilation by the tissues, so that sugar accumulates in the blood. Where there is great pathological disturbance of the system sugar may be formed by the conversion by the organism of proteins and fats into sugar.

It is obvious that what takes place during what is here described is due to imperfect regulation by the

living organism of certain of its normal processes. The pancreas apparently plays an important part in such regulation, and it has been known for long that by interfering with it diabetes may be artificially produced. But other organs are involved, for if there is not co-operation between these organs in maintaining the normal level of the processes concerned, the symptoms will appear. These may assume various menacing forms. The sick man may waste away from inability to metabolise the carbohydrates necessary for the maintenance of life, or, for want of carbohydrate conversion, acids may be formed in the blood by disturbance of the normal regulation of reaction in the body. The foreign acid produced will bring about coma and death if it is present in sufficient quantities.

I have referred to this phase of metabolism because it is another illustration of the fashion in which the living whole exercises regulation of the processes in which it is actual and which constitute its life. When these processes are interfered with the health of the living being is affected and its life may be brought to an end. The facts seems to point to a control which is incapable of a mechanistic explanation. We seem always driven to the notion of life realising and maintaining itself in a flux of material which is constantly being taken in and given out. There is continuous nutrition, and continuous reproduction also, of cell and other life in the healthy subject, and this takes place consistently with behaviour in the fulfilment of a further end which is accomplished, that of growth and development through a course of life, from conception to death, in the interest of the species.

I will take yet another piece of testimony to this from the records of results established, this time by biologists. There is a microscopic unicellular organism which is found in rivers and ponds and is called Arcella. It is specially interesting when examined under the microscope, since there are observed in it gas-bubbles within its protoplasm. When these bubbles appear they make the animal lighter, so that it can come to the surface of the water. It has been discovered that a comparatively slight deficiency in the normal oxygen percentage of the water causes the Arcella to develop bubbles at once and so to come to the surface. What takes place is a visible intra-protoplasmic gas secretion, and the gas seems to be oxygen. Now what the Arcella does is no isolated thing without parallel in other cases of living organisms. The secretion of oxygen in the swim-bladders of fishes was discovered a hundred years ago by the French physicist and chemist, Biot. He was engaged in survey work on the Mediterranean, and he noticed that deep-sea fishes caught with a line at great depths came to the surface with their swim-bladders distended with gas or even bursting. He examined the gas and found it to be, not ordinary air, but oxygen. He observed that the greater the depth from which the fish was taken the more did the gas in the swim-bladder approximate to pure oxygen. In the end later research showed that the secretion of this oxygen was under the control of the nervous system, the secretory nerve being one of the branches of the vagus.

As nearly pure oxygen has been obtained from the swim-bladders of fishes living at a depth of 4,500 feet, it is apparent that oxygen may be secreted into this

bladder and retained in it at a pressure of over 120 atmospheres, while the partial pressure of the oxygen in the surrounding sea-water is only one-fifth of an atmosphere. It seems to follow as the inevitable inference that the liberation of oxygen and its retention by the semi-liquid wall of the swim-bladder is the result of an active physiological process in the living cells lining the walls, and cannot be explained mechanically. This and other evidence seems to show that living animal cells have the power of liberating or secreting free oxygen, and do so in accordance with the requirements of the organism as an entirety. They seem to work for the maintenance of whatever are the normals under the conditions which obtain from time to time.

In these and countless other instances we find that a living activity cannot be made intelligible apart from its relation to other living activities. What it accomplishes is apparently directed to the maintenance of the normal condition of the organism. The parts of a machine are intelligible in independence of and as external to each other, and they can be put together by a process of addition. The structures and activities of the parts of a living whole appear quite differently. They are functions within wholes which are determined as such through control by ends. To comprehend life we have to employ conceptions which do not belong to mathematics and physics but which are essential in the phenomena of life. It is no question of mere forms of knowledge. We do not tend to distort some reality existing apart from these conceptions by bringing it under them. The reality forces them on us. It is what it is only inasmuch as they enter into the actual with which we are

confronted. Why do many men of science struggle to resist this conclusion, and take the actual to have no other relations than such as consist in externality to each other of entities and actions? Because of their unconscious metaphysics. They think of minds as things, looking out of boxes called skulls, on entities which exist in themselves without any relation to knowledge. But both the mind and its object seem rather to fall within knowledge, and we have therefore to ascertain what knowledge means before we can indulge in any such unverified hypotheses as are current. If the object of knowledge be always individual, with logical moments which are real only as belonging to it, and if of these moments some are of a universal character, belonging to thought, while others are in the nature of vanishing particulars, asymptotic limits in analysis which are actual only if and as they are set in universals of reflection, then we get to a new notion about our experience. It is always individual in form, concerned with what is just this and unique in the universe. But the individual object that is just this individual is what it is only because of its setting in knowledge, and the mind or subject which we take to know it is in the same case. Both fall within a fuller and less abstract entirety, experience no longer taken to be a property of a 'thing,' but as founded in knowledge. Now knowledge has an infinity of forms which it assumes. These vary with the relation to it of its world and with the ends which it sets before itself. We always have relativity to knowledge itself as the result. The forms of knowledge which we employ in our study of life we seem to employ not because of any arbitrary choice, but because in the actual world in which we

as men have our stations and our duties we find them there as readily and as truly as we find those of the sciences which require a fuller measure of abstraction from the actual. It is no question of entities, for there are none such independent of knowledge. It is a question of standpoints within the entirety of the knowledge to which we and our objects alike belong. Knowledge seems to be the foundational fact. It is, still more than in the case of the velocity of light, a constant which we always presuppose. Knowing, and not being, comes first in fact as in logic. But to understand the meaning of this we must eliminate from our imaginations the picture of knowledge as a property of a thing in space and time. Indeed space and time, as the physicists themselves are telling us to-day, are constructions relative to the observer, by which bare change is differentiated into relations which depend on standpoint.

CHAPTER VIII

PSYCHOLOGY

There are few scientific words that have been used with such varying meanings as 'psychology.' The general and popular idea about it is that this science is concerned with forms of activity displayed by something usually called 'the mind,' which can be scrutinised in complete detachment from himself by an observer who turns the lantern of introspection in upon his private soul, thus held out for observation. But in another view of the science it is that of the behaviour of the organism, equally regarded as expressing what is 'mental,' but as an external object. Such behaviour includes everything from merely reflex action in neural processes to the manifestations that people call intelligent. The two views are more often than not sought to be correlated and brought into combination.

Aristotle, however, would tolerate neither of these opinions. He smiles at those who hold them as being the victims of obsessions. Nor is it really to the point to say that he knew nothing of the advances which modern science was to make. If he had known the entire physiology of the nervous system as it is understood in our own times, it is plain that for him it would have been irrelevant for the solution of his problem. He had rejected the notion according to which mind and body are two self-subsisting and mutually exclusive forms of being. They were for

him logical phases in the concrete reality of everyday life, the individual reality in considering which the observer, not aware of limits to which his procedure is subject, is apt to detach each from the other and to hypostatise it into a separate thing. For Aristotle reality was what it was in virtue of the meaning which it expressed. Behind its relation to knowledge we therefore could not go. The soul represents the true meaning of the body, so that body cannot accurately be said to exist apart from soul, and it is through soul that bodily processes attain their true significance. Soul and body are for Aristotle not simply a harmony of independent existences. They fall rather within a unity in which the bodily functions require us to have knowledge of the soul in order to bring out their full significance and reality. "We must then," he says, in the *De Anima*, "no more ask whether the soul and the body are one, than ask whether the wax and the figure impressed on it are one, or generally inquire whether the material and that of which it is the material are one." Matter cannot be separated from form. Reality is that which it becomes. The object and the capacity to perceive it are correlatives, differing only in the way in which they are approached. They are different aspects of a single actuality, one side of which expresses itself in the activity of perception, and the other in the concrete individual thing perceived.

It is not sufficient to dispose of Aristotle's view to say that it is two thousand years old, and was that of one who knew nothing of modern scientific results. It is true that he had no understanding of the Baconian principle as we have applied it. It is true

that he was unacquainted with our sciences of measurement and of quantitative research. But he had the sense of ancient Greece for quality, and, possessing this sense, he had an almost unrivalled gift for detecting unconscious metaphysics and for dragging to light crudeness in philosophical assumption. It is not clear that our sense of quality in this respect has advanced beyond that of the great Greek thinker.

We must, therefore, in approaching the consideration of modern psychological methods, bear in mind the Aristotelian criticism of the assumptions which are apt to disclose themselves as their foundations. But with this word of caution, that the methods cannot be used for erecting any structure more reliable in point of finality than the character of these assumptions warrants, we may turn to the psychology based on methods which, in their fashion, have proved highly fruitful. We may approach it from the standpoint at which the physiology of the brain and nervous system forms its instrument. Or we may rely on introspective methods as our instrument for getting at the character of mind. Or we may proceed by both paths.

As to the second and third of these methods of approach, objection has been taken. Those who belong to the school of 'Behaviourism' raise strenuous doubts about any other plan than one. They warn us that we must look to external observation, and to that alone, for the meaning of mind. They deny that introspection is a reliable or valid method of acquiring knowledge of its nature. Results supposed to be so reached are not really scientific. It is only what we do, and not what we think, that can be accurately

ascertained. When we imagine that we are observing our own thinking we are in truth only observing our behaviour as living organisms in the habit of expressing themselves in forms of action which we call intelligent. The study of the behaviour of other animals is the key to the study of the behaviour of human beings. What we add in the latter case is a construction by inferences which are artificial and unwarranted. It is, for instance, not any psychical idea that leads the bee to fashion the cells in the honeycomb as it does. It is not prevision, but instinct developed in response to stimulus. This, as even writers who do not accept the full principle of the Behaviourists say, may be traced to biological origins. Professor Lloyd Morgan, for example, in the second chapter of his well-known book on *Instinct and Experience*, restricts the term 'instinctive,' in a biological acceptation to which he gives a large scope, to congenital modes of behaviour dependent upon inherited dispositions within the lower brain centres. "The sequence," he says, in summing up the outcome of this chapter, "of instinctive experience, correlated with a physiological sequence in the cortex, though it is a conscious sequence, and though it affords data for an associating process, is not *in itself* a psychical process proper, because its course is not determined by conscious relationships, but is determined by purely organic and physiological relationships, comparable to those which subserve the digestion of food. It is just for this reason that I do not regard it as conative, since I conceive that it is of the essence of conative process that it is determined by conscious relationships with their attendant psychical values."

There are, as I have already suggested, some

possible obscurities which are ignored in the various views just alluded to. Before we can proceed to study mind we must know what we mean by mind. Is it anything that can be adequately represented as merely an object in space and time for the observer? Or do space and time present themselves excepting in relations, and in relations which vary, to mind? Is mind separable in our experience from our knowledge about it? And can mind be described in any way which goes behind itself as presupposed in all of them?

It is evident that it is indispensable in the investigation of mind to study the biological organism in which what we call mind expresses itself. But how are we to approach this study? One way is to define in advance the object of our researches as the discovery of physical and chemical laws which are assumed to be all that life means. Some of the difficulties which attend this assumption we saw earlier when considering physiology. If the final category is to be the form of mere succession in external series the facts appear impossible to account for. And yet this category seems to be the only one permitted to themselves by the school of philosophers in which Mr. Bertrand Russell, to whose book on Mind reference will be made later on, is a brilliant leader.

Another way is to take as primary the biological category of end, as operative immediately and presently, in contrast with the cause which is treated as an entity distinct from its effect. This is the method with the aid of which, as we have seen, some physiologists are now studying life itself. Behind the terms in which life is spoken of for everyday purposes

of recognition they do not go. They dread, when tempted to do so, the effects of unconscious assumptions. In this restricted fashion we may safely aim at understanding life, but not consciousness.

A third way is to abstain from taking the world of actual experience to contain only a single type of entity or of relation. If reality is not from every point of view separable from our knowledge of it, but is fashioned by concepts which in giving it meaning give it also existence, it is necessary to attend to the character of the concepts employed in its interpretation. These are not events or happenings in space and time, or entities separable from the mind observing, but are not the less determinative of the character of what is itself actual, and must have account taken of them. It will therefore be necessary to see what the biological organism yields to observation and experiment, shutting out no standpoint which these appear to disclose. The process will have to be analogous to that appearing in restricted form in physiological research, where the standpoint seemed to disclose itself in what was observed, as it had been found to do in the instance of physical measurement and shape.

All that I wish to do at this stage is to suggest the great necessity for caution. The methods used in the special sciences are apt to imply fundamental assumptions which, if wrong, turn out to have coloured illegitimately the results apparently reached. The advantage of being critical in the use of dominating conceptions is therefore great from the outset. It seems to be the sense of the necessity of this care in some form that has led many physiological psychologists to treat their own work as provisional

only. They refuse the reduction of mind to matter, or of matter to mind, as a purpose with which they are not concerned. Just as the æther is a name for that, whatever it may be, in which the phenomena of the magnetic field in physics exist, so they are content to assume provisionally what is called a soul. But about this they make no pronouncement excepting that it is the domain in which neural processes disclose the production of psychical processes. Experience, they think, may in course of time throw further light on the question. For the present the only safe attitude is that of a sceptical agnosticism which leaves the problem of whether the soul is more than a sum of physical events unanswered. They think that experience shows that some neural process invariably accompanies every state of consciousness in the higher as well as in the simpler phenomena of mind. But on the implications of this they are of opinion that they cannot safely pronounce. The science of psycho-physics has not up till now in their view enabled them to offer a judgment on the question, and it may turn out to be one which their methods cannot solve.

Not the less these restricted methods have very great value. If we interpret them as the methods which are appropriate for investigating the behaviour of the living individual, in doing what may be more than merely physical or even physiological and is called mental, we have not yet got an adequate definition. We do not know so far what mind means. But we have excluded methods which deal with what is looked at only as mechanical, such as the leverage of the body in pulling up a weight, or only as physiological, such as the influence of the living structure

taken as a whole on the functions of each of its organs. This does not mean that the employment of these methods may not prove to be of the highest importance as aids in psychological research. Just as mathematics and physics and chemistry are required in physiology, so these and physiology itself are of vital importance for the psychologist. But it does mean that the primary domain of psychology is one in which certain of the distinctive features are those of conscious action, and that where even what is akin to it, like instinct, has to be included for study along with conscious purpose, this must be done with contrast in view to action that is consciously directed. Purpose as against mere biological end is what tends to mark off this region, and its conceptions go beyond those of end, taken to be no more than end. There is a difference not merely in the character of the facts but in that of the standpoint and interpretation adopted. We no longer in our abstraction exclude sensation and feeling, although we have to take account of factors that do not in themselves come directly within the range of consciousness, inasmuch as they belong to what is external.

On the other hand, we are aware that beyond our private sensations we do not get in external perception. When we say that we all see the same sun, moon and stars, what we really mean is that we all invest our private sensations with a meaning which is the same as the meaning that others give to their sensations. Into his particular sensations none but the individual who has them can penetrate. Perception is everywhere a business of interpretation, of the recognition of logical identity in difference. Thoughts are no mere happenings in space and time.

If they were we should never be cognisant of the thoughts of our neighbours. Even the fullest psychological investigation must therefore, if it stops short of a philosophy of some kind, fail to carry us to complete understanding of the world external to ourselves.

Nor does our internal world, as revealed by introspection or by even the vaguest self-consciousness, stand in any better case. The barest feeling is what it is for us only by virtue of its being distinguished in some form of knowledge. It is recognised by being classified, however loosely. It is so classified only by virtue of the general or universal aspect it presents, an aspect which has no subsistence apart from a particularism that takes shape in an individual form which is actual only in that both moments enter into it. No doubt if we can resolve the universals of knowledge here and elsewhere into something more foundational, say self-subsistent entities succeeding each other in order of externality, we shall get further. But this requires us to become metaphysicians of a particular school, like, for instance, Mr. Bertrand Russell, and even when we think that we have at last arrived, it is only to find ourselves confronted once again with the individual in its form of concrete universality. Behind the fact that in some form we always know we seem unable to get. But if so neither the physiology nor the psychology of the day, nor both in combination, bring us any nearer the solution of the problem of the character of the ultimate reality. Their value is to enable us to study scientifically a particular aspect which presents itself in a special domain of that reality, and in this respect they are analogous to mathematics and physics. Such study is, like study in these other

fields, of far-reaching importance. But its limits have to be understood. When some of the most modern physiological psychologists inform us that they feel bound to recognise psychical processes as reacting on neural processes, and that there is a ground of unity of psychical process, they sometimes go on to call this the 'soul.' It may be necessary for them to employ some such appellation. But the meaning they seem to attribute to the name is one that defines some self-subsistent entity. The alternative interpretation appears to be to look on the organism, say of a human being, as the expression of more levels than one in a hierarchy of knowledge. If the actual is only actual through its relation to knowledge, if in knowing we are always more than we take ourselves to be, and are exercising no mere activity of a thing in space and time, then we shall no longer worry ourselves with the task of finding a metaphysical meaning for 'soul.' We shall take the expression as signifying that the plane of knowledge is more than merely physical or even biological. We shall say that when we find the neural processes as apparently disclosing psychical reality we are recognising in them a fuller character belonging to their actual nature when it is investigated from this standpoint. In other words, we shall take the facts as we find them, refusing to be deterred by metaphysical assumptions that they cannot be what they seem. We shall, in short, take seriously, here as elsewhere, the relativity of reality to its mode of apprehension by mind. Such mind can therefore be itself no effect and no substance, for these presuppose it as their foundation. Not the less it is there for us to study in the varying forms in which it expresses

itself, and one of these is its self-display in the intelligent activity of the organism.

If we can in this way free ourselves from our unconscious assumptions we may find ourselves delivered from embarrassment in approaching the problems of physiological psychology and of introspective psychology alike. They both present illustrations of knowledge that is only of a particular kind or degree and is therefore relative. But not the less on that account do they belong to knowledge, and knowledge which may be of scientific value. When people talk of neural and psychical processes as causally related we shall not deny the truth of their observations. We shall only interpret the word 'causally' in a different sense. The uniformities will not be the less on that account ascertainable by science. Nor shall we trouble ourselves over difficulties about 'epiphenomenal' aspects or the description of consciousness as being of this nature. What we seek for is freedom to observe and record the facts without distraction, and this freedom the fuller view of knowledge and of the relation to it of reality seems to permit us. It leaves us at liberty to be grateful for the light which physiologists, by study in minute detail of the structure and functions of the nervous system, are throwing on the behaviour of the organism. It leaves us not less grateful for the increased refinement which introspective psychological methods have introduced into the study of mental phenomena, such as those of association, aided by new experimental adjuncts which biology helps to furnish.

Physiology is now enabling us to understand more completely than before the great part played in the

life of the organism by reflex action. Movements which are reflex are such as are determined by a chain of purely physiological processes. Some physical stimulation, for instance of a sense-organ of the skin, is transmitted through the sensory nerves into the spinal cord, along certain neural channels in the cord, and out along the motor nerves that pass to the muscles, the contractions so stimulated in them bringing about movements. It seems, if we take the ordinary view that the organism and the soul are separate entities, and not different aspects of one reality, as though there could be no point at which mind intervenes in such reflex action. In a carefully guarded sense this is so. But the statement has to be made subject to two qualifications. In the first place such action does not appear to be merely 'causal' in the meaning in which the word is used in physics. A stimulus is of an order different from that of such a cause. It is adequately intelligible only on the footing that it is a phenomenon of life dependent on the presence of the living organism as an entirety and controlled by ends. It is no case merely of events fashioned by external causes. In order that the stimulus may operate the life of the organism as a whole must come into play. You cannot produce reflex action in a corpse. Even when the living body is in deep sleep or unconsciousness, as under the influence of a drug, it is still a living body conducting itself as such, and it is in this aspect that it presents the phenomena of reflex action apart from consciousness of it. In the second place the view that in the relation of soul to life we are concerned with difference in standpoint as distinguished from entity excludes

the idea that we are to inquire how soul and body act on each other as causes. No doubt there are many aspects of our objective world in which we do not find mind expressed. But this does not imply that it is somehow physically excluded. All our conceptions of the orders which confront us in apprehension are the outcome of a process of abstraction. From pure mathematics upwards this is so. Whether in the course of progress towards fuller comprehension we shall not discover at any point that we require conceptions significant of mind in order to make complete interpretation possible, we cannot tell *a priori*. The transition, for example, in biology from end apparently unconsciously realising itself to consciously directed purpose, is not a difficult transition for introspective psychology, and it may be that for physiological psychology the two orders in reflection will turn out to have been isolated merely as the outcome of abstraction. Indeed the progress of the latter science seems to indicate more definitely than ever that this must be kept in view. For recent research, such as that of Professor Sherrington and others, seems to preclude the old notion that the effects of external stimulation of the sensory nerves always terminate at some place in the brain where a soul which there encounters and interprets them has sensations, and itself, in response, produces active movement in the motor nerves. We now know that the brain resembles the spinal cord, and that stimulation passes through channels of a highly complicated and differentiated nature to the motor nerves, in a fashion akin to the reflex action in the spinal cord. But even if it be true that neural process can be separated from

psychical process, it seems pretty clear that all psychical process is accompanied by neural process.

Some very important questions which arise in this connection are discussed by Professor McDougall in his book on *Physiological Psychology*. He points out the value, in connection with the physiological phenomena which he describes, of the new knowledge which is coming into being about speech, about sleep and fatigue, and about what is popularly called mental life. But he adds that the objective methods of psychological study presuppose a basis attainable only by subjective or introspective methods. The work of the physiologist, however valuable, is therefore valuable as possessing an elucidative rather than an independent character. To that observation I venture to make this addition. There is no field of knowledge in which there is not required more than one order of conception for its interpretation. The conceptions which enter into and fashion our ideas of individual objects always belong to a plurality of orders in knowledge, and therefore, in the objects themselves, to the reality which is relative to it. The physiology of an intelligent living organism can hardly be exhaustively studied apart from the fact of intelligence.

The observation I have just made, agreeing so far with Professor McDougall, is no merely academic one. There is prevalent a tendency to regard the behaviour of the mind as though it could be accurately described only in terms of physiology or physics. Even a very competent exponent of educational systems does not hesitate to tell us that for accurate and easy thinking about education it is necessary "to select the facts about which to think, and, above all, to choose facts

which are *simple*, even if imaginary like the line which represents the direction of a hedge. Thus, in formulating principles of education we shall, for the most part, focus our attention upon the comparatively simple material aspects of the brain, rather than upon the mind or soul, of the person being educated." This is written by a man who has not only a high and comprehensive view of education, but is far removed from being a materialist. He believes, like Professor McDougall, in the directing influence of a real soul upon the organism, in 'interaction.' But the result of his principle in investigation is to direct his study of mental phenomena away to 'neuroses' and 'neurograms or neural dispositions,' and to find this standpoint appropriate for an investigation of the objects to be aimed at in education. Now that physiology is a valuable adjunct and a necessary one in the study of psychology, few would question to-day. It plays the part that mathematics, physics and chemistry all do as a necessary adjunct in biology. Every field of study analogously implies the bringing to bear of various orders in reflection. The reflection is abstract and inadequate if it is confined to one standpoint. But there is always an aspect which is characteristic and dominant as marking off the particular field. Its reality, always relative when understood fully, but yet characteristic, is what marks off the subject matter from different subject matters. Now education is characterised by being pre-eminently concerned with freedom in development. To understand free mind as expressed in a biological organism we have indeed to make full use of the light that is cast on the behaviour of intelligent persons by sciences which take no account of conscious

and self-directed purpose or of personality. But these can give us nothing by itself adequate. They are required as the physiologist requires physical science. But they can take no account of the phenomena of self-consciousness, inasmuch as these latter are actual only at another level in the hierarchy of knowledge. And such knowledge in its entirety is implicitly presupposed as the origin and foundation of all the distinctions which fall within its field, and so make reality what it is.

We shall see later how introspective psychology has tended of late to make an hypostatisation which is analogous, though quite different. The point is that although hypostatisations of this sort may be necessary for limited purposes, as they are with the mathematician, they are but partial guides to the character of the actual, and are admissible only for definitely limited purposes. If the closely limited nature of the purposes is not interpreted and kept in view such methods may be very misleading. Not only in education but in practical medicine the failure to consider this is giving rise to uneasiness among those whose daily concern is with the facts of human life. The medical practitioner has been of late complaining of 'preliminary studies,' such as chemistry and physiology, as being of little use. He is wrong. They are of great use if only they are undertaken with sufficient width of outlook to prevent them from degenerating into what is too abstractly conceived. In the same way the complaints about the use of physiological and psychological methods in the teaching of education are misplaced. The subjects are highly valuable if taught with the warning that, although they yield light, they are not exhaustive or

even adequate sources of light. Here, as elsewhere, more standpoints than one are essential in interpretation. The soul which has to be educated is that of a free and conscious person, however the personality is conditioned in physical expression. It is therefore primarily more than the mere physical expression in a brain and nervous system that must always be in view.

The study of this physical expression casts none the less much light on the organisation of the soul and of its modes of activity. The human organism marks the highest point attained in biological evolution, and the principles of heredity and of growth assist in the understanding of its evolution. In man the family of vertebrates reaches a much higher level in cerebral development than in the case of any other member of that family. The brain constitutes a segment which is not, as in the cases of vertebrates of a low type, merely one of a series, but is a part of the body possessing a special dominating importance and control. In order to provide for great freedom of action in dealing with the environment special sense organs which have been developed to a high level acquire not less highly developed nervous connections with the ganglia of the most important segment. The brain of man is related to the spinal cord, and to its own basal ganglia, analogously to the relation which obtains in the cases of animals lower than man. But the brain itself in his case has reached a higher stage in development. The cerebral hemispheres depend, no doubt, on the greater number and complexity of what constitute the factors in the culminating portions of the nervous system that are its basis. But that which distinguishes it in man is still more the enor-

mously increased and complicated multitude of neural arrangements which become increasingly organised as experience of life progresses. It is pre-eminently in man that the cerebrum is capable of so adapting its structure and its functions as to bring about habits in action and dispositions peculiar to individuals. Here, as everywhere else in the brain, the nerve-cells do not exist in isolation. For purposes of nutrition and growth they may be regarded each by itself. But they really discharge functions in the interests of the entirety of the body, and depend for their lives on co-operation of the parts within the whole to which they belong. Such nerve-cell organisations are generally spoken of to-day as neurones, a term which seems to have been chosen as indicating that cells do not really exist isolatedly. The neurone includes not only a nucleus of the cell, but protoplasmic substance which surrounds that nucleus. It is out of such neurones that nerve fibres are built up. As to how nervous impulses are conducted along nerve fibres little seems to be known with any degree of certainty. There are waves of electrical energy which travel from the point excited when a nerve is stimulated, but much more than this fact is required for an adequate description of the character of nervous impulses. We seem here to be in the region of self-adaptation in response to ends to be fulfilled, and beyond anything which merely mechanical descriptions fit. As far as I can find, the action which takes place when the neurone is stimulated is of a metabolic character. The living cell substance alters its composition, and gives rise to some form of energy. On the other hand, it restores itself afterwards from its environment in the fashion referred

to earlier when we were concerned with biology. If this be so no merely chemical explanation can be sufficient. Here, as elsewhere, the categories of life yield the only terms in which life can be described.

In the complicated living system in which the organism consists neurone is related to neurone. They combine in sensori-motor arcs or systems in which the nervous impulse is conducted from sense organ to muscle. This requires the junction of at least two neurones, a sensory or afferent and a motor or efferent neurone. Chains of neurones may be joined in this fashion. The junctions are known to physiologists as synapses.

In the work already referred to Professor McDougall gives an account of synapses, and dwells on the importance of their capacity to resist the passage of energy from neurone to neurone. This capacity to resist may be much affected by the state of the blood, by drugs, and by influences such as were discussed when we were considering the nature of life in the last section. Professor McDougall points out that repetition of the process of transmitting energy across a synapse tends to lower its capacity for resistance, and that a permanent lowering thus brought about appears to be the mode of formation of neural habits, and so of high moment. "If," he says,[1] "the conclusions just stated are well founded, the part played in the nervous system by the synapses is supremely important, for it is the various degrees of resistance of the innumerable synapses, variable by the several influences enumerated above, that guide the course of the excitation-process initiated in any sensory neurone, as it spreads from neurone to

[1] *Physiological Psychology*, at p. 32.

neurone through the maze of the nervous system, and determines its issue by this or that group of motor neurones to this or that group of muscle fibres. For, as was said in Chapter I, the sensori-motor arcs, even those of the spinal level, are not commonly simple and isolated from one another, but are combined to form neural systems of various degrees of complexity. And no one system is completely isolated from the rest, for, if the nervous system is in a state of abnormal excitability, a stimulus applied to any small group of sensory neurones may initiate an excitement which spreads throughout a very large part of the nervous system and throws almost all the muscles of the body into contraction. But when the nervous system is in a normal condition, the excitation-process resulting from a stimulus of moderate strength applied to a sensory neurone, or a group of sensory neurones, spreads through a limited system of arcs and excites a co-ordinated contraction of one group of muscles only. The neural system was defined as a group of sensori-motor arcs so connected that when any one part of it is excited through a sensory neurone the excitement tends to spread to the rest of them. We now see that such a system consists of neurones connected together by synapses of low resistance, and we can understand how simple systems, consisting of a few neurones united by synapses of the lowest degree of resistance, may be connected together by synapses of rather higher resistance to form more complex systems, and these again by synapses of still higher resistance to form still more complex compound systems. We can understand, too, that since the resistances of the synapses are

liable to temporary variations from various causes, the effects produced in the nervous system by a stimulus of given character and intensity applied to any group of sensory neurones may be very different on successive occasions."

The passage just quoted throws light on much that is matter of daily psychical experience. Our quickness in apprehension, our readiness to respond to perceptions, are subject to physical conditions. We may vary in capacity from day to day. The explanation here given is of a kind that is much more than merely mechanical. It is more than merely biological. It is an explanation that applies to the living structure regarded as having a psychical aspect. Not one in which the psyche is a thing apart from the brain and nervous system, but one in which these are looked upon as capable of signifying reality at a stage that is higher and more concrete than what is disclosed merely by the microscope. Apart from introspective experience the phenomena described would lose half their significance. In man and the intelligent animals the organism presents itself as factual at a level that is more than merely biological, and apart from the conceptions it expresses and that are peculiar to such a level it would lose much of its meaning and be no longer actually what it is for us.

In man, too, there are regions in the organisation of his nervous system which mark his progressive development from the lower vertebrates. To these he is closely allied by what we find in the region of the spinal level, and the reflex system which connects excitement of the sensory nerves with the stimulation to movement of muscles and groups of muscles.

Here, as elsewhere in the body, the neurones are grouped into sensori-motor networks or arcs. But the sensory paths are prolonged so as to reach the arcs of the cerebral hemispheres. If we look at a physiological drawing of the brain we notice located on it various areas as being the sensory areas for the different senses. The visual area is in one place, the auditory, tactile, and olfactory areas in others, and the region of the muscular sense in one different. Nervous fibres pass down through the grey material of the cortex from these various sensory areas to join the various motor mechanisms of the spinal level. The afferent neurones of the sensory parts of the body appear to be closely connected, in the sensory areas of the cortex, with efferent neurones that connect with motor systems of the same region. It is in the cerebral hemispheres that the passage of excitation of the nerves is attended with consciousness in the form of sensibility. Pain and pleasure are experienced as connected with these sensation-reflexes. As Professor McDougall observes (at p. 49 of the book already quoted): "At every moment very many different stimuli are playing upon my sense-organs. Variously coloured rays of light are entering the eyes, waves of sound fall upon the ears, the skin receives stimuli from the clothes and all other objects in contact with the body, the contractions of skeletal muscles excite the nerves of the 'muscular sense,' and many of the nerves of the visceral system are almost constantly stimulated. Some of these stimuli excite only pure reflexes like those just mentioned, but most of them excite sensations and sensation-reflexes. Of all the objects that thus excite sensation my attention is given to only

one at any moment, only one of them is at that moment an *object* for me in the psychological sense of the word, and if I am absorbed in thought my attention is given to none of them. Nevertheless, all these sensations, excited by objects to which no attention is paid, are present to consciousness in an obscure manner, they constitute a field of undiscriminated or marginal sensations, and are the principal constituent of the rich and massive, though vague, background of consciousness on which the object of attention at any moment stands out as the most prominent feature of the state of consciousness."

Experience points to the fact that we do not have sensations atomically, as if succeeding one another or as co-present in isolation. They seem to belong to a field out of which we can only bring them under attention by act of abstraction in which they are singled out and distinguished amid a multitude of other sensations, in an entirety to which all of them belong. It may be that the stimuli themselves are always complex, and that the feeling is excited in the sensory areas of the cortex of the brain. It may well be also that assistance can be got in understanding the principle of the association of ideas by looking at the facts from a physiological point of view. For the structure and functional activities of the different parts of the brain disclose a basis on which physical association takes place, and this cannot be dissevered from the corresponding psychical association. Moreover, the functions of the brain are localised functions, and it is not irrelevant that the sensory nerves which communicate with them are nerves having individual and specific functions.

There is evidence that points to the cell junctions or

synapses as being the region in which psycho-physical processes really manifest themselves most plainly. For the organisation of neural processes in systems seems to consist chiefly in the establishment of these junctions, and their development. The less complete the development the greater the psychical manifestation appears to observation to be. When the point has been reached at which resistance is overcome the psychical manifestation tends to disappear. Professor McDougall observes under this head,[1] that "what we have to accept as a well-established view is that some part or parts of the sensori-motor arcs of the intermediate level, where they traverse the cerebral cortex, are of a highly peculiar constitution, such that the process of transmission of the 'nervous impulse' assumes in them a very special or specific character, that this highly specialised nervous substance is not of one character in all cases, but exhibits a certain number of varieties which give rise to a corresponding number of kinds of psycho-physical processes, each of which excites one of the elementary qualities of sensation." It does not appear that any ordinary physiological explanation can be found of how these processes come to be brought together in the unity which characterises mental activity. The factors in mental unity are not atomic as they are in chemical combination, in which they remain separate entities even while combining. What happens appears to belong to a different order in experience. It is not necessary or even logical to assume that this different order implies a substance, existing in itself and yet different from other physical substances. The soul, if the term may be used, is not to be assumed

[1] Ub. sup., p. 61.

to be a thing. When I look round on the rich world that surrounds me it is not a collection of causal processes subsistent by themselves that I see. It is rather a world which requires all orders of reflection for its explanation, and levels of objectivity which express conceptions beyond those of physical and biological science. The ethical and the beautiful aspects of reality are not to be got rid of by any attempt to reduce them to relations in which they cannot even be expressed. It is more consonant with common sense to start with what is actual, and explain physical relations as reached downwards by abstraction from what is more concrete. Just so the brain conceived purely biologically, not as expressing function in a living and intelligent human being, but only as it appears when dead on the dissecting table, seems to be no adequate representation of the brain conceived as the organ of mind, in a man into whose individuality all the varieties of ethical and social relationships enter. It is the old story of trying to exhaust the individual by universals. The process is one which can never operate exhaustively or reach a conclusion. There is always some level lying beyond which the concentration of abstract reflection and observation excludes. So far, but only so far, does such reflection yield truth.

This consideration becomes still more apparent the further we proceed with the study of the brain in the higher animals. The perceptual organisation is a complex of sensori-motor arcs of various physiological levels. It is not merely sensory nerves in the area where sensation arises that we observe contributing to mental process. We find arcs of a

higher level which are indispensable for the evoking of images, and for co-ordinating motor impulses. The control of the muscles of the body; the inhibition of the activities of other parts of the nervous system by the drawing to itself of energy in the case of the part that is for the moment dominant; the diminution in other systems caused by the activity of the perceptual system which is in action,—these are among phenomena which physiological psychology brings under study. As correlative to psychical process they enable us to get light on its operation. But they do not exhaust the necessity for a further standpoint in that study. The brain consists of almost innumerable systems of neurones, organised with varying degrees of completeness and intimately interconnected. Some of these systems are congenital, while others are built up during the course of life through its activities. Instinct appears to belong at least mainly to the inheritance that is congenital.

But there are phenomena which seem to require a further standpoint for their explanation. Diversion of the passage of energy by 'drainage' throws some light on the difference between attention and inattention. More, however, is required in order to make intelligible the further phenomena of volitional as distinguished in experience from automatic movement. Here what we call 'will,' action in which self-consciousness is present, confronts us. Professor Stout, in his *Analytic Psychology*, dwells in detail on the differences we encounter here.

These differences are not absolute. Volition shades into automatism as the result of habit. But when we are carrying out the result of conscious reflection the successive phases of action are not detached

from each other and do not follow a time order which usage has established. What determines the order and form of action in conscious volition is the conception of the process as a whole, and of an end to be realised in it. The distinction is the old one between cause and end, but the end is here a consciously adopted end, and therefore a purpose. This is what actual experience of the facts seems to teach us.

Now it is no doubt true that in the higher levels of a fully developed brain the organisation is of a very complex nature, so complex that physiology can to-day describe it only in the barest outline. Even if we assume, what is almost certainly true, that every process disclosed by introspection has a neural counterpart, this assumption in itself guides us but little in psychological interpretation of the phenomena of volition as observed from the standpoint of ordinary physiology. If we include ends as disclosing themselves in operation from that standpoint, we are still a long way from having before us conscious purpose, with its apparent freedom both in selection of order in succession and in shaping and even creating. We seem here to be beyond the level, not only of physical, but of biological conceptions. To import the notion of a self-subsistent entity, physically different from the neural processes in which it expresses itself, is to court confusion. If the assumption is only the outcome of a restricted metaphysical assumption, it seems safer to throw over this assumption and to turn to the possibility that reality, here as elsewhere, may disclose itself as possessing levels or degrees which have their counterpart in the levels or degrees of the conceptions in our

knowledge to which all reality appears to be relative. If an effort of will discloses itself as a voluntary concentration of attention upon some object, it may be a percept or idea, and if its physiological correlate is a high degree of concentration of the energy of the brain along some system of paths, then we may have to look upon the higher phases of brain organisation as being expressive of more than mere biological ends. Unless we make up our minds that we are free to do so it is difficult to see how we can attain to any explanation that is adequate to the facts. A human being, living in society, obeying its laws, manifesting even the minimum of intelligence and self-determination that is required to make him human, endowed with ethical, æsthetic and religious qualities, is not to be explained merely biologically. Why should the phenomena of his brain be so explained any more than those of the complete personality? In the living and intelligent being the brain belongs to his personality, and expresses it in the same fashion that any other of his aspects does. If the methods of necessity employed when the brain taken by itself has to be studied do not admit of the conceptions which personality implies, that warrants only the inference that these methods are, like other methods employed in science, of necessity abstract, and inadequate as a means of attaining to the fullest truth about the nature of the domain of reality in which we find ourselves.

It is here that the limits of the assistance which physiology can render to psychology appear to come in. Of great assistance to the psychologist these methods undoubtedly are. But they play the part which mathematics, physics and chemistry play for

biology itself, and no further part. Experience as an entirety is wider than all these, which constitute only certain of its forms.

We are thus driven to the use of introspective methods in supplement of those which physiology provides. But here, too, we find ourselves often confronted with the limitations sought to be imposed on us by the mind which limits its categories. If the self is assumed to be a 'thing,' capable of being sufficiently studied as though it were only such, we inevitably fall into trouble. Metaphor drawn from the domain of mere observation at arm's length becomes rampant. If the soul is only intelligible as deriving meaning and therefore reality in virtue of distinctions made within knowledge, it cannot be interpreted excepting as an object which knowledge discloses, an object which will be inadequately conceived unless it is recognised that its reality is relative to knowledge such that no one level is exhaustive. A view obtained from a single standpoint may be of great value, but it does not disclose the full truth. It is only by letting knowledge exhibit its own development and its own stages in that development that we can interpret the actual adequately.

What is called 'psycho-analysis' proceeds on this limited footing. It treats the self as a thing to be studied apart from its relativity to the categories employed. We have always to work in this way in our finite investigations, but we have not the less to bear in mind the limitation of the results reached. How closely limited these may become by the metaphors drawn from other levels of knowledge we shall see if we take as our example one of the best-known systems of psycho-analysis.

About forty years ago Dr. Sigmund Freud of Vienna, afterwards Professor in the University there, made certain investigations into cases of hysteria. He came to the conclusion that the origin of the hysteria in these cases was the unconscious repression by the patient of the presence of hidden experiences, mental dispositions which had passed into the region of the unconscious, and which had originally been attended by emotion. The memories of these experiences had passed into unconsciousness, but were not the less active and were being unconsciously repressed. Upon his studies Freud founded the well-known theory which is elaborated, with a multitude of illustrations, in his book on *The Interpretation of Dreams*. By him the force which represses unpleasant thoughts and keeps unconscious wishes from getting through into the region of conscious knowledge, is called the 'censor.' The term 'wish' is used in his psycho-analysis as covering all sorts of yearnings and ambitions. Of these a great many are in existence but do not come into consciousness, owing to repression by the censor. They constitute none the less a working basis for dreams, neurotic symptoms such as stammering, and many sorts of mental conflict. The dream is a true expression of unconscious mental content, and is the fulfilment of a repressed wish. A mass of latent ideas is condensed into the momentary dream as it is remembered on awakening, and to find its basis requires analysis of the dream itself. It is generally forgotten because of the dominant wish to forget the ideas on which it is based. This wish is a form of 'resistance.' One valuable function of dreaming is to make sleep possible by rendering such ideas momentary and

unrecognisable by the sleeper. The only sort of dream which disturbs sleep is the nightmare, which is an anxiety dream. For Freud hysteria is the result of the effort of the mind to disguise its unpleasant thoughts and experiences. That is why it takes the form of mental conflict. It is due to ideas which are not harmonious with the rest of the patient's personality. When these ideas are repressed the repression gives rise to peculiar mental states, to loss of memory, or even to behaviour and physical conditions which may characterise hysteria, such as stammering (an anxiety form of nervousness), paralysis, blindness, loss of sensation, feeling of unreality and so on. The true way for the physician of dealing with such pathological conditions is to explore their origin with a view to detecting and breaking down the resistances in the past which have produced them. How has all this come about? Only an exploration of what the real working of our minds has been can show. The value of preventing experience early in life of the undue working of fear or shyness may thus prove of much use in preventing the acquisition of abnormal habits later on. This sort of penetration into the origin of symptoms in nervous pathology constitutes at the same time their treatment. The unconscious but yet present motives and desires which are disclosed in various physical disturbances, and even in some manifestations in ordinary life, are got rid of if they are brought into consciousness. Freud has inquired into the dreams in particular of persons mentally afflicted, and claims to have been able to trace the genesis of delusions, morbid fears, hysteria and insane ideas. The basic conception of his psycho-analysis is the

existence of definite division between the individual consciousness and its unconscious basis. The method of psycho-analysis is not the usual disclosure by the patient in answer to the questions of a physician of the history of his affliction. In that case the patient can offer the records only of his self-consciousness. It is the reduction of the contents of consciousness to the sub-conscious origins with which psycho-analysis is concerned. It affects on this account to be a new science. Dreams, symptomatic action, and what are called association tests, are among the means by which each symptom in the patient's mental life is sought to be resolved. What are called his 'emotional transferences' are examined with a view to ascertaining possible reasons for resistance to the analysis, and when these reasons are made explicit they tend to disappear, so that the subject is brought to a utilisation of his mental energy in a way more profitable than that of expending it in unconscious neurotic conflict. The art required implies considerable scientific study and training. As might be anticipated, the sexual instinct has a high place among the reasons hidden in the region of the unconscious which are operative. But there is a large school of psycho-analysts who hold that Freud has gone too far in this direction, and give more room to other tendencies in nature.

What distinguishes the new method from old ones, depending only on introspection and suggestion, is held to be that what the new method aims at is to remove something definite, the influence exercised by the abnormal mental resistances, while the other methods merely aim at adding something. The object of psycho-analysis is to produce self-know-

ledge, not to hypnotise or to reduce mere surface effects which may recur for want of removal of their causes. The analytic process of the new school seeks to transfer into a fresh and safe channel the emotions brought to light. What the physician has to do is to unlock the door which resists the emergence of the hidden complex, and this he does scientifically and sympathetically until it disappears and the patient becomes normal and the symptoms disperse. The hidden complex consists in ideas with emotion attaching to them. They are there, but an unconsciously exercised purpose has shut them in, so that they emerge in dreams and other symptoms not under the control of conscious and free mental activity. Much of 'forgetting' is really unconscious, and so involuntary repression. In the phenomena of duplex personality and in somnambulism this makes itself apparent. The hidden vital energy or instinct is sometimes called the 'libido.' This is by no means always of a sexual nature. It may assume the form even of hunger.

The unconscious is for the school I am referring to the domain in which lie the contents of the self of which we are not aware. It is spoken of as 'unconscious' mental life, an expression which is sometimes preferred to 'sub-conscious' or 'subliminal,' inasmuch as it does not suggest any spatial relationship. In this domain of the unconscious are stored up wishes and ideas, often impossible of fulfilment in actual life, and they are kept there by the censor of consciousness. When these wishes and ideas seem to be fulfilled in dreams it is because the censor of awakened intelligence has been feeble or absent, and has allowed them to slip past it as dreams. Often the unconscious

wishes and ideas get through in only symbolic form, and then psycho-analysis traces their existence through the symbols. Myths may be the symbolic expressions in this sense of a whole race.

Sublimation, or the refining away of baser qualities, is the process which the physician of this new school employs. It is the unconscious conducting of the repressed emotions into a new channel. The patient is guided away from mere resistance, and the mental energy, instead of being expended on mere resistance, is directed to fashioning the emotion into some good shape. Sublimation along religious lines is common. The patient, being made aware of his buried mental processes, becomes gradually released from the oppression of their fixed character, and the conflict arising from inner resistance yields. The energy of the unconscious self is no longer pent up, but transfers itself in the patient, now aware of it and duly encouraged, into fresh channels. Moreover, the unconscious is the region where character lies, and the contents of this region must therefore be transformed if the character is to be improved. The character of a person may be largely dependent on childish impulses and reactions against them. Thus a spoiled child tends to become an impatient adult, and a day-dreaming boy may grow into an unduly taciturn man. The origins must in all such cases be detected and brought to light. A healthy self-consciousness, no longer repressive, but seeking to use the hidden tendencies for good ends, will do the rest.

Such is a bare outline of the doctrine of Freud and of those who have found in him their teacher. It is obviously not a scientific doctrine to the same degree as is physiological psychology. It aims

rather at practice. It is therapeutic, an art at least as much as a science. Its nomenclature and its descriptions are based largely on metaphors which, however useful for practical purposes, throw but little light on the ultimate character of reality. It is not surprising, therefore, that even those who recognise in Freud's teaching the initiation of a new method of inquiry should have developed much criticism of its foundational assumptions. We shall see presently why this has been so. For the moment it is enough to say that objection is taken to the drawing of a sharp boundary line between the conscious self and an apparently numerically different unconscious self, with a censor, also outside consciousness, guarding the gateway between the two. Such a picture is said to be merely metaphorical, and to be also untrue of the phenomena of the mind. Psychologists who employ more strictly scientific expressions have raised a number of points about this, some of which require attention.

Investigators who rely on introspective methods, as well as some whose attention has been concentrated mainly on physiological study, have been busy over various questions. One of these relates to the proper significance of the expression 'unconscious.' Another is concerned with the place in the science of mind of 'instinct.' A third refers to the characteristics which distinguish instinct from mental activity proper. Looking at this last question, there has been discussion over what is called the 'All or None' principle as characteristic of instinctive reaction. This principle signifies that the amount of the reaction does not depend on the amount of the stimulus, but that, if a neural stimulus takes place

at all, it always results in a reaction in full force. It has been suggested that in this lies a quality which distinguishes instinct from conscious action, in which the extent of the action in volition is proportioned to the object sought to be accomplished. In physiology there are some reactions of the 'All or None' type which are familiar. We are here dealing with stimulation and not with causation proper. If Professor Lloyd Morgan is right in the passage quoted earlier, in which he treats instinct as a function of the subcortical centres, it is intelligible that a slight stimulus should in all normal cases release the same amount of stored-up energy. It is said that the extensor thrust reflex, obtainable by touching the skin beneath the pads of a dog's hind foot, which remains within wide limits unaltered although the strength of the stimulus is varied, illustrates the principle. But it is pointed out that, however true the application of the principle may be in the case of certain nervous reactions in physiology, it does not fit the facts in many cases of instinctive behaviour, such as those in which the emotions of fear or anger are instinctively exhibited as varying with the character of the object. Obedience to the principle is therefore no sufficient general characteristic of pure instinct.

It is accordingly held by some recent writers that while instinct is innate it cannot be sharply marked off from the rest of mental content by any such principle. It may display a cognitive side, and often enters into cognition proper, inasmuch as it renders possible, in virtue of innate disposition, perception and discriminative treatment of objects independently of previous individual experience. We see this in the case of men of high aptitudes. The

power of calculation, for example, seems in certain individuals to be due in large part to a natural freedom from uncertainty in apprehension, through which they predominate over others. Yet such capacity is properly treated as an intellectual one, although it apparently depends on unconscious as well as on conscious quality and varies with the subject to which it is applied.

In order to avoid the difficulty so arising it has been of late suggested that a distinction should be drawn between mental *structure* and mental *functioning*, and that we may accept the view that consciousness is not co-extensive with the whole field of the psychical. Mental structure may be outside consciousness, while mental functioning may be within it. Thus the observation of the structure would be limited to a merely 'behaviourist' method, aided by inference from introspection. The mind would consist in this view not merely of ideas or presentations but of the structure which regulates their appearance, a structure which would form the domain of the unconscious.

This brings up at once the difficulty first referred to of drawing a line of demarcation between the conscious and the unconscious. Freud does not allow himself to be embarrassed on this point, but his escape from it is largely due to his copious use of metaphorical expressions. Is there any definite line of demarcation between the two different sets of facts? There is of course much of which we are not immediately conscious which yet influences us. What significance is to be attached to telepathic methods we hardly yet know. But much that has been learned and has since been appa-

rently forgotten is still present for some purposes, hidden, it may be, in 'the pit of the ego,' as it has been called without prejudice, but capable of being brought back into actual knowledge. The limits of the field of the object of self-consciousness are neither physical nor fixed. The process in awareness appears to be dynamic and to stand for nothing static. Thought is always qualifying feeling, and feeling is continuously giving actuality to thought. They are never divorced in our actual experience. When we use the methods of psychology in its current forms we seem to arrest the process and to stereotype what is only one aspect in which by our abstract methods we force it to present itself. For practical use we may draw a distinction between the domain of the conscious and that of the unconscious. We may even employ this distinction for scientific ends if we remember how artificial it is. But it does not seem to correspond to the full reality or to give adequate expression to the full truth.

If the principle on which this book and its predecessor, *The Reign of Relativity*, are founded be a reliable one we are delivered from the embarrassment of having to look to either physiological or introspective psychology for the *ultima ratio*. These are sciences which, like other sciences, fashion in their standpoint the aspects which the actual presents for them. The brain and nervous system which the physiological psychologist is dealing with are, let us assume, those of a living man. Well, they are just as much expressive of human personality as is any other aspect of the individual man. They are expressive of more than mere life. They are the manifestation of a soul. Of course when they are dead and laid out on the

dissecting table they are so no more. Mind is no longer expressing itself in them. What is a means is no longer fulfilling its function. It is in virtue of concepts, which are not happenings in space and time, but are logical identities in difference, that we cognise and recognise personality. I have given the reasons for saying this in Chapter VII of *The Reign of Relativity.* All that physiology can yield is a science, limited in the character of the reality which is relative to its particular standpoints, as are the abstract characters with which physics and chemistry deal. That is no reproach to the particular sciences concerned. It is not really their aim to go beyond their special undertakings. If knowledge be in truth the entirety, and the standpoints of the special sciences represent levels within its hierarchy, this is intelligible. We are dealing, not with entities, but with forms which our experience assumes. It is the doctrine of Aristotle, of Plotinus, and of some of the modern leaders in philosophy. What it warns us against is the treatment of knowledge as an attribute or activity of a thing. If we treat it so we may be using a valuable abstract method, as we do in mathematics. But although valuable as being indispensable for the concentration which is required for the extension of exact research, such knowledge is of a limited order. It cannot guide us to the ultimate truth about the reality it is concerned with because it has fashioned that reality into its own restricted image before moving at all.

Let us then rather regard the active and intelligent man as having in his brain and nervous system, while he remains active and intelligent, what is akin to the rest of his personality and interpretable only

at its level. Physiological psychology can give us help in studying phases of his self-expression, but it cannot reach his personality. The reason is that the soul is no thing, nor any structure in space or time, but an aspect in which the human organism presents itself at certain standpoints. At these the brain while, but only while, it lives and acts is an integral manifestation of personality. Physiological psychology is therefore just physiology with introspective psychology brought to its aid.

Then introspective psychology itself is no less a science which has fashioned the actual in its own image. In this science we look into our minds, holding them out for inspection after the fashion which John Locke made famous. No doubt there have been here immense advances in method, made since his day. Experiment in the laboratory has made such advances possible. But the standpoint and the categories or conceptions implied by him have not varied. The mind is treated as a thing to be observed *ab extra*, and not as self-disclosing. Such a standpoint gives us much. It has yielded a body of knowledge which includes, not only what is contained in the textbooks of psychology, but much of what is included in treatises on logic. Still, from this standpoint, the inquirer does not regard knowledge as being foundational or what is always presupposed along with the distinctions which its dynamic character is ever setting up within itself. Among those are the differences between reality and unreality, present and past, truth and error, good and evil, beauty and ugliness, universal and particular. It is only in terms of knowledge itself that these get the meaning which is constitutive of their actuality.

Our own minds we come at as signifying what is thus established within a system of knowledge outside of which we cannot travel even in thought. In being apprehended as objects for knowledge these minds get their meanings for it and for the fashion of their reality with a significance and appearance which depend on standpoint.

These considerations appear somewhat to reduce the importance of the distinction between the domain of the conscious and that of the unconscious. It may be that the search for a definite line of demarcation is a vain one. There is no reason why, for purposes belonging to a psychological standpoint, we should not recognise aspects of reality falling within the system which includes all knowledge, instinct and conscious selection, and connect these aspects in our physiological studies with structural arrangements in the spinal system and the lower brain centres and arcs. But we must not leave out of sight that even for the physiologist the life of the organism is that of a whole, in which the life of the whole not only influences, but is indispensable to that of every organ or part. So with introspective methods. It is not clear that we can treat the conscious and the unconscious as separate entities. The methods which do so appear indeed to have more practical than scientific value. Within our experience the one shades off into the other. Much of our highest activity in reflection, in conduct, in art, is unconscious of itself. It is not on that account irrational nor does it belong to a different self. It is mind developing itself in its own activity. As has often been pointed out, by among others Professor Stout, psychologists are apt to ignore the constructive

side of mental process even in its lower phases. When I have experienced in the past a particular sweet taste, in connection with a particular appearance of sugar, it does not follow that association means that the sense of sweetness associated with the appearance of another piece of sugar is the particular sweetness previously experienced. It is surely a new idea of sweetness connected with the appearance or conception of the present bit. A universal of reflection enters into the concrete individuality of the sugar as I conceive it. There is here a construction based on an inference from past experience which does not belong to direct awareness. There may be and are regions which have no counterpart in any actual experience. But when elements come from them into my awareness they come into the world of my conscious experience, and there attain reality. There is no other real world. There may be what is loosely called 'double personality,' two centres in the same individual from which memory is differently focussed. A line of demarcation between two series in experience may exist. But it is a shifting one, for otherwise there would be two individuals. What I am at the moment unconscious of is something beyond what I am actually aware of. But it falls within the identically same mental activity which I bring to bear on other experience, and it is in this respect at least continuous with it. The unconscious is therefore no world which is subsistent in itself and apart from me. Although outside my present experience it is continuous with it. For bare feeling by itself would be non-existent because meaningless. There can be no other world of bare feeling, and when the limits within which I am aware are extended they are so

extended just by the increased scope of my recognition through concepts, and not merely by the intrusion of what has no actual existence apart from these concepts. The notion of an unconscious existence, a 'subliminal self,' to use the phrase of the late Frederic Myers, seems to be an hypothesis founded on a metaphor which will not bear criticism. There is only one object world for the self, an object world which is always expanding or diminishing, but which owes its significance to the constructive activity of intelligence operating in universals. This is the fact from which we start in human intelligence, and the view which the evolution theory gives us does not contradict it. For that view, while true from its own standpoint, is only a relative one which does not explain the basic starting-point of the knowledge within which the object world it postulates has a place but only a place.

The principle of evolution or development is one which we find only in a world of externality. We get at it by the study of different organisms, or different stages of the life of the same organism, in such a world. Introspective psychology may get light by supplementing its own methods with those used in physiology. It has done so in the case of the association of ideas, and the explanation which weakening of synapses under the influence of habit throws on this. But sensations are never presented for it as self-subsistent things, or as entities existing independently of each other. The character of our actual experience excludes the possibility of this. A particular is always defined through a universal, even in the recognition of contiguity in time or space, and the unique individual object of knowledge always implies

both particular and universal as logical constituents so implied. That seems to be of the very essence of what in experience we name existence.

The point I am pressing is that there are essential limitations to the kind of information about the ultimate nature of mind that psychological methods can furnish us with, whether they be physiological or introspective. Psychology is just as good a science as any other, for there is a similar limitation in the case of every special science. It has fashioned reality in its own image by the use of exclusive conceptions. It therefore is no guide to the final reality which requires knowledge in the entirety of its forms for its full interpretation. It is the tendency which its practical applications carry with them to restrict the significance of their subject and to regard it mechanically that suggests caution in their use. There is little danger when psychological methods of inquiry are directed to such practical questions as arise in industry as to industrial fatigue and about applying human energy in factories, the reduction of monotony, and the increase of interest in work and the distribution of rest periods. Valuable guidance, much of it of a negative kind, may be gained by psychological inquiry into the conditions of study in schools. But the system of education generally appears to be a subject too great to be reduced to psychological principles. It is concerned with human personality, and this is not adapted to mechanistic consideration. The free self-determining soul requires influences in its development which depend on conceptions of a larger order. To attempt to employ unrestrictedly those of one that is narrower is to fall into a very common form of what we call pedantry.

With this qualification we may fully approve of the new use which is being made of psychological work in education. Genetic psychology throws light on instinct, on habit, and on the effect of environment. It teaches that even very young children require a form of education in mental habits. It gives new meaning to what was written by Froebel and by even Rousseau It throws light on method in class-rooms, and on the badness of old and familiar methods of teaching languages and other subjects. The teacher ought therefore to be sufficiently instructed in this kind of psychology, and there are now good practical textbooks which can guide him. But do not let the teacher imagine that the main source of his activity should ever be sought for merely in studies of this kind It depends much more on his own personality and knowledge, and on his power of bringing these to bear suggestively on the youth with which he is in daily contact.

I referred earlier to 'Behaviourism.' The most consistent statement of the principle is to be found in such books as *Psychology from the Standpoint of a Behaviourist*, by Professor John B. Watson, who has taught it at the Johns Hopkins University.

In his writings the reader does not find any reference to consciousness, or to such terms as 'sensation,' 'perception,' 'attention' or 'will.' Even thinking and memory are redefined in terms of physical behaviour. Attention, for instance, signifies for Professor Watson the attainment of a form of bodily organisation and of its function. The method of studying the mind is for him genetic, and if the student could grasp the genesis of the various types of its genetic organisation, he would be able to understand the organism as a

whole. For mind is just a mode of its functions. He insists on the necessity of looking at the influence of the entirety of the organism in interpreting its activity, just as do modern physiologists generally. Language, for instance, is implicitly what we really mean by 'thought process.' We have no right, according to his view, to separate the biological activities which we name as intelligent from other 'organisation processes.' Nor are we any more at liberty to treat consciousness as a correlate of cortical activity. All we really actually do is to watch our own expressions to ourselves. They are words which we utter inchoately, and the thought we take them to present to our self-observation is "not different in essence from tennis-playing, swimming or any other overt activity, except that it is hidden from ordinary observation, and is more complex and at the same time more abbreviated so far as its parts are concerned than even the bravest among us could dream of." Everything in science and in art, and in religion, Professor Watson claims to be able to interpret thus. Instinct is a combination of congenital reflexes unfolding serially under appropriate stimulation. The reflexes form here a chain. Emotion and instinct are not separated by any sharp line. Both are hereditary modes of action. But "in emotion the radius of action lies within the individual's organism, whereas in instinct the radius of action is extended in such a way that the individual as a whole may make adjustments to objects in his environment." The former is "implicit mass action," while the latter is "explicit definatised and localised action." The method of observation in Behaviouristic psychology differs from that in physiology mainly in this, that

while physiology directs observation to part reactions, psychology deals with the adjustments of the organism as a whole.

Now there are points of real value made by the Behaviourists. They insist rightly that it is as a whole that the living organism must be studied if it is to be understood as intelligent. They lift us to this extent above the standpoint of mechanistic biology and treat this as inadequate. Much light is to be got by such interpretation of certain of the activities of the organism. Movements may express reflection, for example. But can we limit the meaning with which we have invested such movements by categories appropriate only to external existence? Does not mind come first, with the meanings which have no significance, and therefore no reality, excepting in and for mind? Apart from being the expression of such meanings what were the words uttered by a human being more than the letters printed in the book he holds? In each case we can give what lies before us a restricted and merely mechanical significance. But is this the full truth about them? Is not the truth the whole, and does not the whole truth and the whole reality depend on our starting from facts as they present themselves at a standpoint that is fuller and higher?

I have now brought to a point sufficiently definite for the end I had in view this survey of the field where the methods of psychology are put in operation. The outcome is apparently to disclose here again the relativity of reality to knowledge.

CONCLUDING REMARKS

CHAPTER IX

CONCLUDING REMARKS

THE actual, as we have seen, does not subsist apart and in isolation, but depends on the form of knowledge in which it gets meaning. The relativity of reality to that knowledge has a wider significance than it possesses even in modern physics. There are variations due to modes of apprehension other than those merely of measurement and of shape. Equally with the latter these other variations are introduced by dominating concepts which determine the character of a reality apprehended and actual only in and through them.

It seems as though we start in every instance from what is concrete and individual, some fact that as it appears in our initial awareness is unique. The truth about such a fact depends for every form of knowledge on how knowledge, setting out from what appears to be its direct object, resolves that object into meanings. It is what is in the highest degree concrete that always presents itself as our point of departure. We do not build up anything in the world that appears to confront us by putting together fragmentary units. For at such units themselves we can only arrive after a process of abstraction. They are come to mediately, and are general and not particular in character. We may present to ourselves the outcome of our reflections as scientific conceptions,

or they may assume the shape, as in ethics, art and religion, of values. But they always bring us back to the actual as being individual and unique in its nature, through the union in it of moments that are both particular and universal, isolable at most in our analysis. It is to the actual in this form that we always return as our basis. Knowledge of this kind as essentially presupposed in the starting-point, the 'that' which is reality, makes this so. Behind the fact of such knowledge we neither get nor can get, nor are we able to resolve this fact of knowledge itself into any terms which do not actually presuppose it at every turn.

If the ideal of our knowledge, as wider than it takes itself to be in the limited outlook of our daily life, is kept before us in the special applications of our endeavours to develop its significance, it becomes a principle which prescribes a fresh standard for our efforts.

It is so that we are brought face to face with forms of value which make a demand on us that is imperative:

> "That low man goes on adding one to one,
>   His hundred's soon hit:
> This high man, aiming at a million,
>   Misses an unit."

We seem to come back for our starting-point to a world that is never in itself any region of merely scientific abstractions. It is rather the rich concrete individuality which Max Planck seems to ask for in the passage from his book on the Conservation of Energy quoted early in the fourth chapter. No one of the sciences, in their various orders in knowledge, presents such a world to us exhaustively. An infinity always

stretches beyond each partial presentation, and no abstract procedure can take us far into that infinity. It is for this reason that Goethe makes Mephistopheles tell the student in *Faust* that those who set themselves to analyse and describe life begin by ignoring its link with spirit. Thereby they get life into their hands but only as a collection of dead fragments. The spiritual bond is missing :

> "Encheiresin naturæ nennt's die Chemie
> Spottet ihrer selbst, und weiss nicht wie."

The outcome of such methods, and of their ethical counterparts, Goethe sums up in the cry of the angels :

> "Die hast sie zerstört,
> Die schöne Welt."

To set out from the world as it seems to be there in all its fulness and in all its aspects is therefore inevitable if we are to attain to truth which will take account of the whole. Knowledge of a range such that this fulness and these aspects should have their places in it as belonging to a single entirety, the unendingness of our human effort to comprehend will not permit. Its incompleteness must remain at all points apparent for an ideal knowledge, in which universal and particular should not seem to fall asunder in the activity of thought nor appear as if even possibly independent. But for us, conditioned as we are by our station in nature, reflection, though limitless in its range, has not power enough to bring together such a vision. Its completion must remain no more than an ideal. But it is yet an ideal which guides and must guide us. It is implicit, whether in science we resolve our object more and more penetratingly through general prin-

ciples, or whether as in Humanism we lay the chief stress on values, and on the concrete unity of what absorbs us by its very individuality. A Riemann and a Newman are swept along by different purposes. Yet their objects are analogous, for they both seek to describe the meaning of the actual. The method is different in science from what it is in poetry or religion. In science the meaning is sought to be thrown into the form of abstract universals, so wide in their range that, like the n-multiply-manifold, they apparently take us away from the individual reality which it is their function to render. But that is not a reproach to the method. For its object is no more than to deal with a certain aspect of reality, an aspect necessary to be dealt with if the meaning of reality is to be developed and its nature made pregnant for knowledge. All science is of this order. Like geometry, it must start from experience, and it comes back to experience interpreted in the new rendering given.

The fallacy that appears to have underlain many attempts at the explanation of nature and that has caused them to fail has arisen from ignoring this basic principle of all knowledge. The metaphysical assumption is made, generally unconsciously, that what are in truth only abstractions are individual objects confronting us. Even in the most modern physics we find the four-dimensional continuum spoken of as though it were something that, in the form in which abstract reflection in the end brings us to it, can be made an actual object in perception. It cannot be so made. That is no barrier to analysis, but such an analysis yields the universals of science and not the concrete individuality of objects which we take ourselves to perceive directly.

It is but too often not only philosophers, but the votaries of science who have fallen into the metaphysical slough. Theologians, hardly less in their own fashion, encounter a similar peril in their difficult path, difficult when they seek to apply the conceptions of one order in knowledge to what truly belongs to a different order. The function of philosophy must always be at least to provide a searching criticism of categories, for without such criticism entanglements in untested assumptions are apt to prevail. That is why philosophical writers like Professor Gentile express themselves almost violently in insisting on the work required to-day from metaphysics, and on the necessity, in the interest of knowledge generally, of the study of philosophy.

It may serve a useful purpose to illustrate these views by contrasting them with one that is different. There is to-day hardly any writer who treats his subject with more apparent lucidity than Mr. Bertrand Russell. Not only is his style admirable, but he is well equipped with scientific learning. He is an accomplished mathematician, and a pioneer in the new method of criticism known as mathematical logic. Recently he has published a book entitled *The Analysis of Mind*, in which his gifts are apparent.

The comment which I shall venture to make on this book is that, like his previous books, it is in truth written by a metaphysician who has not satisfactorily weighed the legitimacy of the categories he employs. For Mr. Russell, whatever he may say, and however he may object to be looked on as one, is a metaphysician of a pronounced sort. At the back of his mind, throughout the new volume, is the faith that physics is the most fundamental science now in

existence. He does not attribute to physics, in its modern form, a belief in the existence of matter in the old-fashioned interpretation of the word. Matter is rather for such physics a construction from events. To Mr. Russell it appears as neither mental nor material, but as a 'neutral stuff' out of which both what is mental and what is material emerge by construction, a view which he holds to fit in well with the outlook of modern psychology.

Such a conclusion must of course meet with the sharpest antagonism from Gentile and other Italian writers, for whom mind is ultimate and is pure activity, antecedent to any object form it may impose on itself, and as such the source of constructions which have meaning only as the outcome of that activity. But without adopting all the language of the Italians it becomes apparent that in the phrases used by Mr. Russell an assumption is made which has never passed without challenge, a challenge which he can hardly be left to ignore without having met it. His method assumes that it is possible to get behind knowledge, and to explain it in terms other than its own. For him there are final data out of which knowledge emerges. These are, as I interpret him, not atoms of matter, which is a construction of reflection, but particulars in the form of entities or events. Such when correlated constitute a momentary condition of some unit which may emerge as physical. Scientific understanding of such correlation and its subject matter, if it were perfect, which it is not, would exhibit the causal laws of the world in terms of these particulars, and these causal laws would be applicable in physics and psychology equally. For physics and psychology do not really differ in their

material. Mind and matter alike are logical constructions. The variety which obtains in the relations between the final particulars distinguishes the study of these relations into that of physics and that of psychology. Even in what Mr. Russell terms mnemic causation there is a causal unit consisting of a group of particulars with a given place for passive observation at a given time, and it is this sort of grouping that distinguishes subjectivity. Habit, memory and thought are explained as being its developments, and consciousness is only a complex but far from universal characteristic which appears in the course of that development. Thus all our data, both in physics and in psychology, are subject to what may be properly called psychological causal laws. "Physical causal laws, strictly speaking, can only be stated in terms of matter, which is both inferred and constructed, never a datum. In this respect psychology is nearer to what actually exists." In a perfected science, he adds, all these causal laws would assume the form of differential equations—or of finite-difference equations, if the theory of *quanta* should prove correct.

Now what are these final data for Mr. Russell, and what are their correlations apart from their meaning for us? Nothing at all! We cannot even state propositions about them, and much less attribute any existence to them, excepting in terms of thought. A bare sensation has no significance apart from our knowledge about it, and as a pure particular, distinguished from nothing else, it never comes into existence. No doubt we affect to give the go-by to this foundational fact in our every-day life. We try to treat intelligence itself as an object which we

detach as one among others in the world. We see a micro-organism, apparently at the bottom of the scale of life, seeming to experience some sensation. We interpret it accordingly. There are many objects in the external world which express even purposive intelligence and freedom. That is because they conform to that order of conception and display it as belonging to their reality. But such reality is always relative to knowledge. In so far as this is so knowledge is not itself an event, or a property of a thing, or a happening in space and time. It is the foundation on which rests the reality of all these. Such reality signifies nothing intelligible unless for knowledge. It is inseparable from meaning. If we could exhibit the whole of the world that confronts us individually with all its phases we should get no further than an object world which was there for mind. Intelligent organisms would appear as having been evolved in such a world, but the whole theatre on the stage of which such evolution unrolled itself would have significance and be something only as present to the intelligence in which the full course of evolution was a fact, significant only for knowledge. Intelligence can therefore be itself, when properly interpreted, no mere phenomenon in such a world. It is rather that within which subject and object alike fall, distinguished only through the foundational activity of intelligence itself.

Such was the outcome of the reflection of the ancient Greeks, and we have yet to be shown how to get behind their analysis. Hardly by suppressing that which lies at the root of all science and all knowledge. The object in these possesses its reality only as relative to the form of knowledge in which it

appears. It is never intelligible excepting as assigned to some order or orders in that knowledge. The recognition of beauty and of truth and of degrees higher than those at which we live our daily lives, is as real as the recognition of causal relations and the entities which stand so related. They are all constructions within knowledge. But when knowledge in this interpretation of the word is recognised as their basis it is not taken to be an event falling within that object world, which is its own creature. It is more than personal. It is an entirety within which all distinctions, including those between reality and unreality, as well as truth and error, fall. Such distinctions are closely connected with the station within nature which is inevitable for us as individuals who are at the same time subjects in knowledge. We are intelligent organisms and our stations condition the scope of our intelligence, although they do not affect its penetrating power so far as we can exercise it. For the entirety, to be which is of the essence of knowledge as such, exhibits itself at degrees or levels at which, taken in separation, we have only aspects of the whole. It is the tendency to assume that the particular orders of knowledge which concern a particular science are the only orders in which knowledge is actual that gives rise to the difficulty which Greek thought surmounted.

We can no doubt exercise our individual freedom as intelligent beings by pursuing abstract methods freely. But when we do so, we do it at the risk of shutting out the fulness of reality. We may, for limited purposes, conceive the basal facts of knowledge as being a succession or an aggregate of psychological entities. But if we interpret mind on this

footing without qualification, it will cease to be intelligible how human beings who are really shut into the mutually exclusive possession of such individual sensation can be aware of an identical world as confronting them all in their awareness. It is only through identity in reflection, through thoughts which are no 'happenings' but are in the full logical sense the same thoughts throughout differences, that we can have a common world or communicate with each other.

Mr. Russell is such an admirable writer, and in his own subjects his understanding is so acute, that one hesitates before venturing to remonstrate with him. But he sometimes, his great quality notwithstanding, appears to assume, as though there could be no question about it, that the standpoint from which he approaches the most difficult questions is the only standpoint open to reasonable beings. Now it may be right, as William James did, to question the reality of consciousness regarded as an entity, and to assign to it only subordinate functions. That may well be a legitimate mode of approach from the point of departure we make when we treat consciousness as a biological fact, or as an object in the procedure of empirical psychology. But is this the only significance which the word possesses? May consciousness not also mean a form of knowledge within an order of thought different from this? It has more often than not been so treated in the history of philosophy, and it seems better not to ignore the circumstance.

Take, again, the insistence of Mr. Russell in other books than the *Analysis of Mind* on the title of the standpoint of mathematics to predominate. There is no science which is more distinguished by the

resolute abstractness of its methods. The exclusion of all the aspects of reality, excepting those of the order in externality with which it is concerned, has been the source of the mathematician's power. But it is an exclusion which shuts out other and necessary significances in the real. 'Continuity' for example has a special meaning in mathematics. In logic and metaphysics the word is used in a quite different sense, and yet those who so use it have been reproached by Mr. Russell for ignoring the mathematical use. They would not, I think, deny Mr. Russell's just title to pronounce against them on any purely mathematical ground. But they would deny that this meaning which they attach to the word 'continuity' is the same as that which the mathematicians attach to it, or that the latter have an exclusive title, like that to a trade name.

Even if we were to start by conceding to Mr. Russell, what he presses for in his *Principles of Mathematics*, the non-existential character of propositions (other than those which assert existence) and "the pluralism which regards the world, both that of existents and that of entities, as composed of an infinite number of mutually independent entities, with relations which are ultimate, and not reducible to adjectives of their terms or of the whole which these compose," we should not be much further on with the problem of continuity. For the purpose of a science which pursues from its exclusive standpoint an abstract method we should have bifurcated the object in knowledge from the activity of knowledge itself, but we should not have faced the difficulty with which philosophical, as distinguished from merely mathematical logic, is thereby confronted.

When we count even such separate entities, we count them in virtue of a continuous quality or identity which pervades them, so that every unit, however small or great, is a distinguishable part within some whole made up of such parts. We cannot enumerate without knowing what is being enumerated. The relation which is thus essential in the meaning we put on the process implies both the nature of the continuity and the rule under which a discrete aspect arises. Quantity, in other words, implies quality as inseparable from it. Thus continuity involves discreteness, and the latter not less the former. The two conceptions have no intelligible significances apart from one another. That is because the essential character of the reflection out of which meaning comes is to be dynamic, and is ever passing beyond the distinctions it makes into what it is contrasting them with.

No one wishes to challenge the right of mathematicians to use such words in another sense, provided that there is borne in mind the different use made of them by metaphysicians in contemporary thought, and also long before mathematics began to adopt the expressions to its special purposes.

It is, of course, of assistance to point out that a series may be said to be 'compact' when no two terms are finally consecutive, but between any two there are others. It is true that in what mathematicians mean by continuous motion the moving body occupies at a given instant a certain position, and at other instants other positions, but that the interval between any two instants and any two positions is always finite, while the continuity of the motion is shown in the fact that however near

together we take the two instants and the two positions, there is an infinite number of positions still nearer together which are occupied at instants that are also still nearer together. In this sense the moving body never 'jumps' from one position to another, but always passes by a gradual transition through an indefinite number of intermediary positions.

This is excellent, but it does not tell us what we want to know, the relation to each other of the conceptions of continuity and discreteness. For light on the significance of this, we are driven back to the underlying interpretation by philosophical logic to which I have referred. Mathematical writers like Cassirer are well aware of this.

Much that is analogous could be said about the contrast between the meanings of the word 'infinite,' as used in mathematics, and the word as interpreted in philosophy. The two interpretations are not inconsistent, simply because they are the outcome of different purposes, and consequently of different standpoints. Neither supersedes the other, just for that reason.

But it is now time to return to the principles laid down in Mr. Russell's *Analysis of Mind*. My objection to them is that indicated. He seems to me to take a particular outlook in knowledge as though it could throw light on the full meaning of the object in knowledge relatively to knowledge as an entirety. His method is a valuable one if restricted to the purposes of a particular form of science. My criticism is that this form of science does not yield the complete truth, nor take us beyond aspects into which the true object is fashioned by a method which is necessarily partial

and abstract. The categories employed appear to require to be critically examined.

But having said this, I do not wish to be understood as lacking in appreciation of the merits of the investigation made within its self-imposed limits. Mr. Russell never fails to inspire me with admiration for his clearness in expression, and for his knowledge in his own department. He is deservedly reckoned as one of the most eminent of contemporary inquirers. In lucidity of statement, I wish indeed that I could rise to his level. Not the less, when he enters on a crusade against schools of thought different from his own, I have sometimes also wished that he had shown more appreciation of what those who belong and have belonged to such schools really said. I know how difficult philosophy is, and how much it needs, what Goethe asked for, a long tract of time through which those who are engaged in its work can co-operate. And if that co-operation is to be effective, it must be based on a sustained effort at mutual understanding of divergent methods. That seems to me to be essential for us finite and fallible searchers after truth.

Now although in his *Analysis of Mind* Mr. Russell is more gentle about other people than he has always been in other books, he not the less tends to ignore that there may be great differences of opinion about method in the approach to the problems with which he concerns himself.

Treated from a particular Victorian standpoint, that in which mind and secondary and tertiary qualities were 'bifurcated,' to use Professor Whitehead's expression, from nature, the analysis is of great use. It has the value which the standpoint of Newton con-

tinues to possess, the principle of Relativity notwithstanding. But it has this value only on the footing that it is concerned with a special form of scientific investigation, directed to obtaining distinctness in knowledge by confining itself to conceptions which exclude all excepting one or two of the many aspects which the actual possesses. On this footing the book is a genuine contribution of an original nature to the psychological inquiry into reality. It resembles the contributions of physics and chemistry to biology. The views expressed in the *Analysis of Mind* throw new light, the limitation of standpoint being kept in view, on several important questions. From this standpoint there is much to be said for rejecting the idea of consciousness as an entity, and for the appreciation of what is of assistance in the 'behaviourist' contribution to method. We may agree with Mr. Russell in thinking that instinct is distinguished from knowledge by requiring no prevision of the biological end which it serves. We may, however, feel colder when he seems to suggest that punishment is an outcome of vindictive impulse. It is surely much more. It is an advance towards the explanation of facts when he tells us that for him mnemic phenomena comprise that large class of responses of the organism which can only be brought under causal laws by including past occurrences in the history of the organism as part of the causes of the present response, and that it is only mnemic phenomena that belong to the domain to which he limits experience. A chain of experience, or a 'biography,' becomes in this way what distinguishes science dealing with living organisms from physics. The proximate cause here may consist, not only of a

present event, but of this together with a past event. Of course that compels Mr. Russell to supersede laws of causation by laws of change, and so to come to order in externality as foundational of reality. He and Professor Alexander appear to hold views which do not here diverge in essentials. But it is not unimportant that Mr. Russell should point out that all that we can know empirically is approximate and liable to exceptions, and that exact laws embodied in differential equations may be true, but cannot be known to be so. In other words, they are conceptual. A piece of matter is not a single existing thing, but a system of existing things. "When several people simultaneously see the same table they all see something different; therefore 'the' table which they are supposed all to see, must be either an hypothesis or a construction." Correlation of points of view is necessary. So we come to views of the world from different places as 'perspectives.' Physics, on the other hand, is not troubled by this multiplicity, because what it attends to is changes in appearance according to the same law. This is followed by an acute discussion of introspection and of 'images.' Through 'mnemic causation' we get to perception, in which sensation is the theoretical core, but the actual experience is perception, always complex. The 'subject' is a logical fiction, like a mathematical point. Belief is 'the most mental thing we do.' It is an actually experienced feeling, nothing merely postulated. A memory-belief confers on a memory image its meaning, and refers us to an object which existed in the past. The causation of images is divergent from that of sensations. Images may be vague. But such generalised pictures can be used to form concepts,

united by the presence of an act of judgment. This leads to an inquiry into the structure of judgments and of what we call, erroneously, abstract ideas. Knowing is not any "mystic unity of knower and known." It is "a very external and complicated relation, incapable of exact definition, dependent upon causal laws, and involving no more unity than there is between a signpost and the town to which it points." Of belief and of sensation itself we *may* be conscious but are not necessarily so. The function of consciousness and thought is to enable us to act with reference to what is distant in time or space, although that may not be presently stimulating our senses. Such a reference is possible through association and habit. Consciousness is "far too complex and accidental to be taken as the fundamental character of mind." What we call 'subjectivity' is the characteristic of 'perspectives' and 'biographies,' the characteristic of giving a view of the world from a certain place.

For Mr. Russell, therefore, knowledge is not the ultimate foundation of reality. We can go behind and resolve it into realities that in fact as well as in logic are antecedent to itself. The difficulties which I have already dwelt on as hindrances to this opinion I will not repeat. The opinion itself has, however, been stated nowhere that I know of more acutely or impressively than it has been by Mr. Russell. His book must be studied in order to appreciate its excellence of its own kind. For all that I have been able to do here is to draw attention to certain points in it.

If the conclusions come to in this book and in its predecessor, *The Reign of Relativity*, are well founded,

there is a criterion of truth in our knowledge which always must be kept in view. It is not enough that our opinions should merely appear to harmonise with what observation of their object is taken to disclose. For that observation may have been directed from an outlook that is too narrow. If knowledge enters into reality and moulds it, whether in physics or in any other domain, we must be sure that the character of the method brought to bear is not stretched beyond the limits of that to which it is directed. If this last is always individual and concrete in its nature, and if the purpose is to find the general conceptions in which that nature can properly be described, we have to be careful. For our object is individual, in so far as it reveals its particular aspect only as set in universals apart from which the particularity would have no meaning and no reality. We have, therefore, in order to get at the types of universal which are appropriate to any individual object of investigation, to remember that these types must be not only general, but as matter of experience characteristic of it. We do not really impose them on the object. It is on us that they ought to be imposed, and our knowledge is relative to them. The phenomena of the ethical world are not those with which mathematics deals, nor is the type of the one form reducible to that of the other. The characters of the universals to which analysis is directed are different in each case, and we have to bear in mind the necessity of accepting the appropriate order when seeking to resolve that which is individual into the general conceptions through which alone it is intelligible. No doubt we can choose conceptions arbitrarily, and adopt a standpoint in our investigation determined by them. But

to do so is to court disaster. For certain categories are found in our experience to be sufficient for the actual facts we are dealing with, facts of which they are the expressions while others are not. We come to this when we exclude the idea that knowledge is a mere property of a thing, and accept the view that both subject and object fall within it as their foundation.

On what principle then are we to fashion our abstractions? Surely by considering first the sort of fact with which we are dealing. If that fact is life, we ought not to assume that we can render our conceptions of it into those of physics. We may have to do this in order to describe certain aspects which living organisms present, but these may be neither the only nor the dominant aspects of the actual in such a case. The criterion required is that we should satisfy ourselves by observation of the actual as to the categories required in its study. Thus the relativity of knowledge gets a further significance, for it is only relative knowledge that we have when the standpoint is one that is not such as to cover the full reality.

A view like this does not affect the accepted criterion of truth in science. It rather insists on that criterion being applied in a more thoroughgoing form than is common. The various branches of inquiry relate to special domains, and we fall into error if we apply general conceptions appropriate only to the character of one domain to description of what is of the order of a different domain. It is observation that tells us in each case with what character we are really concerned. We are not in difficulty over this if we are careful to start in our study with what is concrete, and not with some abstract distortion of its nature,

due to insistence on a special standpoint arbitrarily adopted. There may be many standpoints from which we can view an individual fact. The question is which of these can account for fact in the starting-point, the actual as experience shows it to be.

The variety of order in which knowledge presents itself, if we do not distort but observe it in its self-development, gives us the key to the variety of its standpoints. Its universals are not difficult to find. But it is one thing to find them and quite another to hold fast to them when found. Most of the confusion which has characterised the history of reflection has been due to the assumption that a particular set of universals would prove sufficient for the description of objects differently characterised in facts disclosed in nature. The inquirer has again and again pursued in consequence a path which has led him away from these facts.

If there is a service which philosophy can render with more advantage to science than any other, it is probably to keep reminding men of science never to forget to criticise their categories before employing them.

THE END

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